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EDITORIAL.

Food Storage Problems.

In two successive numbers of this Journal will be found a general article on the subject of food storage* and an article dealing specifically with the storage of rice† on a small or medium scale. Particular attention is directed to this subject at the present juncture owing to the desirability of maintaining the supply of essential foodstuffs within Malaya.

The successful storage of foodstuffs demands, firstly, that the product at the time of introduction to the store is in a condition suitable for storage; and secondly, that conditions of storage are such as to ensure that this state of affairs may be maintained satisfactorily during the period of storage. In other words, the design and construction of the store should be such as to minimize deterioration of the stock and to make it possible, efficiently and systematically, to remedy, or at least localize, damage should this become evident. Whatever precautions be taken to ensure that the product is originally in a fit state for storage, deterioration from one cause or another is always possible. The danger must be met at an early stage and the spread of damage checked.

It is evident, therefore, that the major points for consideration are the design and construction of the store. If it is desired to store a foodstuff for but a short period the unit for store space, or section of store, may be as large as is necessary to cope with the entire crop, but if the stock is to be kept for a considerable period, or to be continuously changed by removals and replenishments—in both cases increasing the danger of deterioration of stock—the unit of storage should be limited to make it possible to isolate stock which is becoming damaged, whether it be by insect attack, moulds, defects in the building or from other causes.

It appears to us that consideration of these elementary principles of storage have too frequently been omitted in connexion with schemes for the storage of rice in this country on estates, in institutions, and elsewhere. We commend the above-

* The Storage of Foodstuffs in the Colonial Empire. *Malayan Agricultural Journal*, March and April, 1940.

† Rice Storage. *Malayan Agricultural Journal.* March, 1940.

mentioned articles to those who wish to store grain or other agricultural produce in this country; we would also remind them that the advice of the officers of this Department may be obtained on application to the Adviser on Agriculture.

The Rice Crop in 1939.

We are now in a position to review the position regarding rice production and consumption in Malaya in the year 1939 and we present our annual statement on this subject in this number.

The long-continued effort to increase the area under this crop and to improve the yield per acre becomes evident in each successive annual review, and the present one is no exception to this record of progress. The season under review, however, was a particularly favourable one for the rice crop, the area destroyed or damaged by adverse weather conditions was below average, while adequate water supply at the right time and generally good weather conditions at harvest combined to make this year's crop a record one.

The present, however, is no time for congratulation, but rather one for renewed effort to render the cultivator less at the mercy of the vagaries of the weather by improved water control and to make his crop more profitable by an improvement in yield and quality. These problems continue to receive the earnest attention of the Departments concerned, and in addition every effort is being made by the technical Departments in collaboration with the Administrative Service to extend further the cultivated area.

We are still faced with the problem that the Malayan production of rice is quite inadequate to meet local demand; in fact, as the following figures show, despite all the efforts made to date as regards consumption and production we still stand in the same relative position as we did 20 years ago. The total consumption of rice in 1919 was 558,000 tons, in 1939 it was 1,000,000 tons while local production in 1919 was 188,000 tons as compared with 340,000 tons in 1939. Thus, despite greater production, we are still only able to produce 34 per cent. of our annual requirements. It is disquietening figures such as these that point to the necessity of exploiting every method to accelerate the rate of development of rice production in Malaya.

Control of Rubber Coagulants.

On another page will be found an account of the steps taken since the outbreak of war to ensure an equitable distribution to rubber growers of available supplies of acids used for the coagulation of rubber latex.

The initial dislocation of imports experienced in the early days of the war threatened to embarrass rubber producers. This dislocation was caused partly by the diversion of shipping for naval purposes and partly because much of the formic acid was obtained from an enemy country.

The arrangements made to ensure adequate stocks and to distribute supplies necessarily caused some worry and perhaps annoyance to distributors and consumers, but disorganization of existing custom is inseparable with the introduction of any measure of control. The most severe critic, however, must admit that the steps taken were effective and that the official machinery instituted has simplified the supply of acids under war conditions. We are given to understand that supplies are now more normal and that there is no immediate fear of an acute shortage of these essential acids. Furthermore, it is gratifying to learn that supplies are now coming forward from Empire sources.

The schemes of distribution adopted threw a not inconsiderable burden on the Department of Agriculture, and it is largely to the Field Staff of this Department, in close collaboration with the Land Officers, that credit is due for the fact that shortly after the shortage of coagulants was realized, available supplies were distributed in an equitable manner.

The assumption of these duties dislocated the routine work of the Field Branch of the Department to a considerable degree, but there were compensations for this dislocation, not least of which was that it enabled the officers of that Branch to urge a lesson to rubber small-holders concerning the correct method of the coagulation of rubber, which previously, with ample supplies of coagulants available, they had been unable to drive home.

Original Articles.

EXPERIMENTS ON THE GERMINATION OF OIL PALM SEEDS

by
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Introductory.

Descriptions have been given in previous numbers of this Journal of the results of various trials undertaken at the Central Experiment Station, Serdang, with the object of increasing the rate of germination of oil palm seeds. ([1] & [2]). Among the methods adopted were: (a) planting the seeds in open sand beds kept continually moist, (b) fermenting the seeds by placing them in pits filled with alternate layers of seeds and cattle manure, (c) soaking the seeds for several days in water heated twice a day to a temperature of 45° C. and allowing to cool, and (d) soaking the seeds in solutions of hydrochloric acid of varying dilutions. The results showed that the most satisfactory method was to plant the seeds in open sand beds, when an average germination of 75 per cent. within a period of 16 weeks might be expected.

Recently the manager of an oil palm estate reported more satisfactory germination from seeds sown in specially prepared beds of pericarp residue than from seeds sown in sand beds. It was also brought to notice that in West Africa, with the object of increasing the rate of germination, the seed is often submerged in running water for 3 weeks to 1 month before planting.

An experiment comprising these two methods and using both fruits and seeds was laid down at Serdang. A period of 24 days was selected for the pre-treatment in running water. An additional experiment was carried out to study the effect on germination of submerging the seed in running water for varying periods up to 36 days.

In the preparation of large quantities of seed for planting and export the removal of the pericarp by paring with knives is a laborious process. A method employed to reduce the amount of work consists in soaking the fruit for a few days in a tub of water. As a result of soaking, the pericarp becomes soft and rotten and can be easily removed by light pounding of the fruits in a mortar with wooden poles. The effect of soaking the seeds for varying periods has been studied, while a further experiment comparing the rates of germination of seeds cleaned by this method when planted in sand beds and in pericarp residue beds has been carried out.

Export of seed raises the question of the effect of long periods in transit on subsequent viability. Comparative experiments were laid down testing seed stored for varying periods after removal of the pericarp both by paring with knives and by soaking as described above.

Details of Experiments

(1) *Comparison of Sand with Pericarp Residue as a Germination Medium for Seed and Fruit, both Fresh and Submerged in Running Water for 24 Days.*

This experiment was carried out in concrete-sided germination beds which are exposed to the sun from 10 a.m. to 5 p.m.

The sand beds were composed of clean river quartzite sand about 12 ins. deep.

The pericarp residue beds were made up by placing a 1 in. layer of the fresh residue from the palm oil factory on a bed of earth. The seeds and fruits were laid on this material and covered with a second 1 in. layer of the fresh residue. On top of this second layer soil was spread evenly to a depth of 1 in. The seeds and fruits were therefore sandwiched in a 2 ins. layer of fresh pericarp residue with earth above and below.

Seeds and fruits, both fresh and after submerging in running water for 24 days, were planted in beds of these two media. In the case of the seeds the pericarp was removed by paring with knives.

The plots were arranged in a randomized block lay-out with three replicates of each type of planting material in each medium. All plots were planted 3 ins. x 3 ins. square and there were 200 seeds or fruits per plot.

The beds were watered daily during dry weather. Germination was recorded at weekly intervals when all seedlings were removed. Table I gives a summary of the results of germination.

Table I.

Percentage Germination Obtained with Seed and Fruit both Fresh and Submerged in Running Water for 24 Days when Planted in both Sand and Pericarp Residue Beds.

Period since Planting	Fresh Seed		Submerged Seed		Fresh Fruit		Submerged Fruit	
	Sand	Pericarp Residue	Sand	Pericarp Residue	Sand	Pericarp Residue	Sand	Pericarp Residue
weeks	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
16 ...	33	14	13	26	9	11	nil.	4
20 ...	69	39	50	59	17	20	2	15
24 ...	83	67	78	76	26	38	6	27
28 ...	87	73	86	80	31	55	9	41
32 ...	88	73	88	81	36	59	11	50

All treatments indicate a much slower rate of germination than expected. Thus, for fresh seed a figure of only 33 per cent. was recorded after a period of 16 weeks in sand compared with 75 per cent. as previously obtained. In this connexion it may be mentioned that considerable variation in the rate of germination of seed has been noticed. This can be ascribed to such causes as variations in maturity of individual fruits in a bunch when harvested and to variations in the amount of sunshine and rain falling upon the germination beds.

Although initial germination was slow, the final figure of 88 per cent. after 32 weeks for both fresh and submerged seed in sand can be considered satisfactory.

Conclusions. The results of the experiment may be summarized as follows:—

(a) In the case of seed, the pericarp residue treatment did not give such satisfactory results as sand beds. Although with submerged seed a higher initial rate of germination was obtained with pericarp residue than with sand (for example after 16 weeks the figures were 26 per cent. for pericarp residue compared with 13 per cent. for sand), this higher rate was not maintained in the later stages of the experiment.

(b) Submerging of the seed in running water for 24 days had no appreciable effect on final germination.

(c) In the case of fruits, increased germination was obtained with pericarp residue compared with sand, although the range of figures with pericarp residue was always lower than with seed in sand beds.

(d) Submerging the fruits in running water for 24 days had an adverse effect on germination. This was particularly noticeable in the case of fruits planted subsequently in sand beds.

(e) After 32 weeks the average germination figure was 83 per cent. for seed compared with 39 per cent. for fruit. The removal of the pericarp before planting must therefore be regarded as an essential for satisfactory germination.

(2) *Effect on Germination of Submerging Seed in Running Water for Varying Periods.*

Six hundred seeds from which the pericarp had been removed with knives were placed in a sack submerged in a stream of running water. Every third day (with a few exceptions) 20 seeds were removed from the sack and planted in sand beds. Fresh seed was also planted as a control.

Table II summarizes the records of germination.

Compared with fresh seed the figures indicate that submerging in running water tended to retard initial germination especially with prolonged submersion. In the case of the submerged seed there was no appreciable alteration in either the final results or the time taken for the majority of the seeds to germinate.

The fresh seed used in this experiment germinated remarkably well, giving 95 per cent. after 16 weeks compared with the normal figure of 75 per cent.

Table II.

Percentage Germination Obtained with Seed Submerged for Varying Periods in Running Water and Planted in Sand Beds.

Period Submerged	Total Percentage Germination after					
	8 weeks	12 weeks	16 weeks	20 weeks	24 weeks	28 weeks
days	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
3 ...	25	60	65	65	75	75
6 ...	nil	40	60	65	80	80
9 ...	nil	35	60	70	70	70
11 ...	10	40	85	95	95	95
15 ...	nil	35	70	90	90	90
18 ...	nil	30	65	85	90	90
21 ...	nil	15	85	90	95	95
23 ...	nil	30	65	90	95	95
27 ...	nil	30	80	85	85	90
30 ...	nil	25	80	85	85	85
32 ...	nil	25	70	95	95	95
36 ...	nil	25	60	75	75	75
Mean of Treatments	3	32	70	82	86	86
Fresh seed, unsubmerged (control)	20	65	95	100	100	100

Note.—The above percentages are cumulative, *i.e.* fresh seed germination was completed by 20 weeks.

(3) *Effect on Germination of Seed Cleaned of Pericarp by Soaking in Water for Different Periods.*

As mentioned previously, this method of cleaning the seed consists in placing the fruits in a tub and covering them with water. A bacterial rot sets in, the water becomes covered with a dirty scum, while the pericarp becomes soft. Four days is the usual time employed. The water is drained off and the fruits pounded with wooden poles in a mortar until the pericarp is reduced to a fibrous pulp. This is easily removed from the seeds by washing them in water. If the seeds are to be sold, they are dried in the open for 2 or 3 days, the few remaining fibres adhering to them being scraped off with knives.

The above method of cleaning the seeds is much simpler and far less expensive than paring off the pericarp with knives.

In the present experiment one batch of 400 fruits was soaked for 4 days and the second batch of 175 fruits for 8 days before planting the seeds in sand beds.

Table III gives a summary of the results of germination.

Table III.

Percentage Germination Obtained with Seed from Fruit Soaked in Water for Different Periods and Planted in Sand Beds.

Period after Planting	Period of Soaking	
	4 days	8 days
weeks	per cent.	per cent.
16 ...	16	30
20 ...	53	61
24 ...	65	72
28 ...	68	76
32 ...	70	78
35 ...	74	82

The results indicate that while soaking in the manner described may have a slight retarding effect on the initial rate of germination the viability of the seeds does not appear to be affected. The mean figure of 78 per cent. obtained after 35 weeks may be considered fairly satisfactory.

It is interesting to note that the percentage germination figures for the seed from fruit soaked for 8 days are invariably higher than those soaked for only 4 days.

(4) *Comparison of Sand with Pericarp Residue as a Germination Medium for Seed Soaked in Water for 4 Days.*

This experiment was carried out on earth beds which are exposed to the sun from 8 a.m. to 4 p.m.

The sand beds were prepared by removal of the soil to a depth of 8 ins. and filling to the original level again with clean river quartzite sand. The surface of the sand bed was flush with the surrounding soil.

The pericarp residue beds were made by first building up an earth bed 6 ins. above the normal soil level and then spreading the layers of pericarp residue and top layer of earth as previously described.

The lay-out of the experiment was a randomized block with 4 replications. Two hundred seeds from which the pericarp had been removed by soaking the fruits in water for 4 days and subsequent pounding in a wooden mortar were planted in each plot. Table IV gives a summary of the results of germination.

Table IV.

Percentage Germination Obtained with Seed Cleaned of Pericarp by Soaking in Water for 4 Days and Planted in both Sand and Pericarp Residue.

Period since Planting	Sand	Pericarp Residue
weeks	per cent.	per cent.
9 ...	1	2
12 ...	7	33
16 ...	25	54
20 ...	45	58
24 ...	70	60
28 ...	77	62
32 ...	80	62

In both media germination commenced after 8 weeks.

The above figures indicate that, at first, germination was more rapid in the pericarp residue beds, in which after 16 weeks 54 per cent. of the seeds had germinated compared with only 25 per cent. for the sand beds. After that, the rate of germination in the pericarp residue beds gradually diminished, a final germination of only 62 per cent. being obtained after 32 weeks. In the case of the sand beds germination continued steadily. The figures show that after 24 weeks a germination of 70 per cent. was obtained, with a final figure of 80 per cent. after 32 weeks.

Conclusions. The results of this experiment support the conclusions drawn in the first experiment, namely, that sand is a more satisfactory germination medium than pericarp residue.

A marked disadvantage of pericarp residue is the difficulty of removing the seedling from the bed without injury. The pericarp residue tends to form a tough matted layer and frequently the radicle is bent, so that on lifting the seedlings it frequently happens that either the radicle is damaged or the seed breaks away from the seedling.

(5) *Effect on Viability of Cleaning Seed both by Paring and Soaking of Fruit and of Storage of Seed for Varying Periods before Planting.*

This experiment was undertaken as a result of large orders being received for seed for export. Although legislation has now been enacted controlling the export of oil palm seed and the subject is therefore no longer of such importance the results are published for the purposes of record.

A heap of fresh fruits was divided into two equal parts. One half was cleaned by cutting off the pericarp with knives, while the other was treated by soaking for 4 days in water as described in (3) above.

Both lots of seeds were dried and placed in two sacks stored on a dry concrete floor. Twenty seeds were removed from each sack at fortnightly intervals and planted in sand beds.

Table V summarizes the results obtained on germination.

Table V.

Percentage Germination Obtained with Seed Stored for Varying Periods Before Planting.

Period of Storage	Total Percentage Germination after				
	10 weeks	12 weeks	16 weeks	20 weeks	24 weeks
weeks	per cent.	per cent.	per cent.	per cent.	per cent.
Pericarp Removed by Paring					
Fresh seed (control)	nil	5	40	65	70
2 ...	5	20	45	65	70
4 ...	10	10	25	40	50
6 ...	5	10	35	85	90
8 ...	nil	10	35	65	85
10 ...	15	45	75	75	75
12 ...	15	30	50	65	70
Mean of Treatments	8	21	44	66	73
Pericarp Removed by Soaking					
Fresh seed (control)	20	25	80	80	80
2 ...	5	30	60	95	95
4 ...	20	25	45	85	85
6 ...	15	30	60	80	80
8 ...	5	25	60	65	70
10 ...	40	55	70	85	85
12 ...	40	40	75	85	90
Mean of Treatments	21	34	65	82	84

Note.—The above percentages are cumulative as in Table II.

The results indicate that the viability of the seed is not affected by storage up to 12 weeks, whether the seed is cleaned by paring the pericarp with knives in the usual manner or by soaking the fruit in water; in fact the mean figures obtained by the latter method are slightly higher than those obtained when the fruits are cleaned by paring the pericarp with knives.

Summary of Conclusions.

The conclusions reached in the various experiments may be summarized as follows:—

(i) Fresh seed planted in sand beds gives the most satisfactory results on germination. A figure of 88 per cent. was obtained after 32 weeks.

(ii) More satisfactory results were obtained with seed planted in sand beds than in specially prepared beds of pericarp residue.

(iii) Fruits planted in either medium without removal of pericarp gave unsatisfactory results compared with seeds under the same conditions.

(iv) Pre-treatment of the seed by submerging in running water for varying periods up to 36 days had no appreciable effect on final germination. There were indications of a slight retardation of the initial rate of germination.

(v) Equally satisfactory results were obtained with seed cleaned by soaking the fruit in water and by paring off the pericarp with knives.

(vi) The viability of the seed was not impaired by storage for varying periods up to 12 weeks.

(vii) Seeds cleaned by soaking and stored for varying periods up to 12 weeks gave satisfactory germination.

References.

1. Curtler, E. A. Experiments on the Germination of African Oil Palm Seeds. *Malayan Agricultural Journal,* Vol. XIV, No. 4, April, 1926, page 84.

2. Milsum, J. N. Hastening the Germination of Oil Palm Seeds. *Malayan Agricultural Journal,* Vol. XV, No. 3, March, 1927, page 82.

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A COMPARISON BETWEEN NATURAL COVERS AND CLEAN-WEEDING ON YIELDS OF OIL PALMS

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Introductory.

Many people are of the opinion that increased crop production has followed the adoption of a cover of controlled natural undergrowth on areas of clean-weeded rubber. If the increase in yield is due to an improvement in soil conditions there appears to be no reason why other permanent crops should not benefit by similar treatment.

The present experiment was laid out to ascertain the effects on yields of fruit bunches resulting from the encouragement of a controlled natural undergrowth under mature oil palms, and how such yields compare with those from clean-weeded areas and areas under which natural undergrowth is periodically slashed.

Although clean-weeding is no longer practised on estates this treatment was included in the experiment in order to provide the additional comparison with land devoid of vegetation apart from the crop itself.

Site of Experiment.

The experiment is laid out on undulating land in fields 5A and 5B at the Central Experiment Station, Serdang. The soil is a sandy loam belonging to the Hill Quartzite group, and is of a somewhat low nutrient status. Some of the palms show premature bronzing and yellowing of the leaves.

History of the Palms.

The newly-cleared area was planted with oil palms in 1922 at 30 ft. x 30 ft. triangular spacing, giving 55 palms per acre. Silt pits, each 20 ft. x 2 ft. x 2 ft., were dug on contour on the sloping land above each palm and a second series of pits was dug below the palms in positions staggered with the first. These pits gradually became silted up; they were redug to their original dimensions during the latter half of 1939. The area was clean-weeded until 1932 when natural undergrowth was allowed to become established. This undergrowth was kept in check by occasional slashing and by weeding narrow strips along the rows.

Artificial manures were first applied in 1932 when the application consisted of rock phosphate and kainit. Subsequent applications consisting of rock phosphate alone were made in 1935 and 1936.

The experimental plots were first marked out in July, 1936, when the palms were 14 years old. Owing partly to the undulating nature of the land the stand of palms was not uniform and good and bad areas were noticeable. As will be seen later, preliminary records of the yields of fruit bunches from each plot were taken before deciding on treatment.

Cultivation Treatments.

The experiment comprises three cultivation treatments:

(a) Clean-weeding.

(b) Slashing. The undergrowth between the rows of palms is kept in check by slashing close to the ground every four months.

(c) 'Forestry' Method.[1] By means of selective weeding of the natural undergrowth the "undesirable"* plants are removed and those remaining are controlled by cutting back to a height of 4 to 5 ft. twice a year. Among the plants which have been removed are:— bracken (*Gleichenia linearis*), stag-moss (*Lycopodium cernum*), and several species of grasses, principally broad-leaved carpet grass (*Axonopus compressus*), maidenhair creeping fern (*Lygodium circinatum*) and sedge grass (*Scleria multifoliata*).

Straits rhododendron (*Melastoma polyanthum*) has appeared profusely on all the plots. On those plots on which there is an abundance of other "useful*" plants Straits rhododendron has been removed, but in some places, particularly on the steeper areas, it has been encouraged.

The plants remaining in most abundance include:—*Nephrolepsis biserrata, Blechnum orientale,* passion flower (*Passiflora foetida*), wild fig (*Ficus* spp.), *Uncaria* sp. and other shrubs.

On the slashed and 'forestry' method plots a clean-weeded strip 2 to 3 ft. wide is maintained between the rows of plants and a 4 ft. circle is clean-weeded around each palm to facilitate harvesting.

The treatments were commenced in March, 1937, prior to which the routine practice of slashing the natural undergrowth had been undertaken since 1932.

Lay-out of Experiment.

There are 15 plots each consisting of 30 palms ($\frac{1}{2}$ acre approximately) arranged in a randomized block lay-out with 5 replicates.

As mentioned previously, preliminary yields of fruit bunches were recorded for 6 months after the plots had been marked out in the field but before commencing the experimental treatments. The method of determining the treatment for each plot was to arrange these preliminary plot yields in three groups, so that the total of each group was approximately the same. Thus it was ensured that at the commencement of the experiment the groups of palms under each treatment were giving about the same yield.

Yields of Fruit Bunches.

A summary of the yield figures for the different periods since the commencement of the experiment is shown in Table I, while in Table II these figures have been expressed as percentages of the yields from the slashed plots.

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* The terms 'undesirable' and 'useful' are here used according to the classification adopted by exponents of the 'forestry' system and the undesirability of any or all of the plants removed from the natural undergrowth in this experiment must therefore be regarded in the light of such a classification.

Table I.

Mean Yields of Fruit Bunches from Plots of 30 Palms.

Treatment	September, 1936, to February, 1937*	March to December, 1937	January to December, 1938	January to December, 1939
	lbs.	lbs.	lbs.	lbs.
Clean-weeded ...	2,271	3,412	4,218	5,359
Slashed ...	2,212	3,363	3,537	4,268
'Forestry' method ...	2,215	3,253	3,149	3,659

* Preliminary period of experiment.

Table II.

Mean Yields of Fruit Bunches for Different Treatments Expressed as Percentages of Yields from the Slashed Plots.

Treatment	September, 1936, to February, 1937*	March to December, 1937	January to December, 1938	January to December, 1939
	per cent.	per cent.	per cent.	per cent.
Clean-weeded ...	102.6	101.5	119.3	125.6
Slashed ...	100.0	100.0	100.0	100.0
'Forestry' method ...	100.1	96.7	89.0	85.7

* Preliminary period of experiment.

As already stated the experiment extends over an area of Hill Quartzite soil of low fertility and in consequence the yields of fruit bunches are low. Taking the conventional factors of 60 per cent. by weight of fruit in the bunch and a factory recovery of 25 per cent. by weight of oil on the fruit, the average yields over the whole experimental area were 1,050 and 1,300 lbs. of oil per acre respectively for the two years 1938 and 1939. During the latter year the clean-weeded plots yielded at a calculated rate of 1,600 lbs. of oil per acre while the 'forestry' plots produced only at the rate of 1,100 lbs. of oil per acre.

Discussion.

The figures obtained during the first 10 months of the experiment show that yields were not affected by the treatments during that period. This is not surprising since it has been shown(2) that oil palms do not respond to artificial manures until 9 months or more after application. Further, there was necessarily a lapse of several months before the 'forestry' treatment became appreciably different from the normal slashing treatment.

The figures for 1938 show that during the year following the commencement of the experiment the different treatments had a considerable influence on yield of fruit bunches. Clean-weeding gave an increase of 19 per cent., whereas the 'forestry' treatment resulted in a decrease of 11 per cent. compared with a normal slashing treatment. A statistical analysis of the figures for that year shows that the yield from the clean-weeded plots was significantly greater, at the 20: 1 chance, than the yield from the 'forestry' plots. The experimental error amounted to 15 per cent. of the general mean.

The yield differences during the following year, *i.e.* January to December, 1939, were even more pronounced. The increase from clean-weeding amounted to nearly 26 per cent., whereas the fall in yield due to the 'forestry' treatment was more than 14 per cent. compared with the normal slashing method. In other words the yields obtained by clean-weeding and slashing were 46 and 16 per cent. respectively greater than the yield obtained by the 'forestry' treatment. A statistical analysis of the figures for January to December, 1939, shows that the yield from the clean-weeded plots was significantly greater, at the 20:1 chance, than the yield from the 'forestry' plots. The experimental error amounted to 19 per cent. of the general mean.

Although the effect of clean-weeding is so pronounced, several years must elapse before a true comparison of the treatments is obtained. It is possible that on the clean-weeded plots the increased yield has resulted from a temporary addition of humus and plant nutrients to the soil following the decay of the former natural undergrowth. After 2 or 3 years, when this temporary increase in soil fertility has been exhausted yields may decline. As regards the 'forestry' treatment, on the other hand, it may be that the reverse process has taken place. Available soil nutrients may have been temporarily 'locked up' by the 'forestry' growth in competition with and to the detriment of the oil palms. When, as a result of the decay of roots, leaves, loppings and undesirable plants, the soil of the 'forestry' plots returns to a nutrient equilibrium, the yield of the palms may increase again, especially in view of a probable improvement in the physical condition of the soil.

It may be assumed that at the commencement of the experiment the physical state of the soil, while reasonably good, was not at a very high level, since the ground had been under a cover of natural undergrowth for 4 years only following a period of 10 years of clean-weeding. On the clean-weeded plots, however, the physical structure of the soil may be deteriorating again, while on the 'forestry' plots where conditions more nearly approach those existing in natural jungle, an improvement in physical structure may now be taking place. If these suppositions are correct the yields from the 'forestry' plots may be expected to increase and those from the clean-weeded plots to decrease during the next few years. Only time can show whether these suppositions are justified.

On the other hand, the results of the experiment to date are considered of sufficient importance as to warrant their being brought to the notice of the oil palm planting community as early as possible.

Although clean-weeding has given the highest yields to date this treatment is not recommended for various reasons, for example, possibility of soil erosion and exposure of the soil to the sun.

With regard to the general question of a cover for the soil a compromise in the form of a leguminous low-growing cover suggests itself. The behaviour of oil palms under such conditions is under observation at Serdang.

Conclusion.

The experiment shows that the effect to date of clean-weeding has been an increase in the yield of fruit bunches, while the effect of allowing the undergrowth to develop according to the 'forestry' method has been a decrease in yield. The experiment must be continued for some years to see whether these differences are maintained before definite recommendations for estate practice can be made.

Summary.

(1) The experiment was conducted on mature oil palms growing in soil of rather low fertility.

(2) The treatments under comparison were:—(a) clean-weeding, (b) slashing the natural undergrowth close to the ground three times a year, and (c) 'forestry' method in which selected natural undergrowth was periodically cut back to a height of 4 to 5 ft.

(3) The lay-out consisted of five randomized blocks, each plot measuring approximately ½ acre.

(4) The yields of fruit bunches were unaffected during the first year of the experiment. During the second year clean-weeding gave an increase of 19 per cent. while the 'forestry' treatment gave a decrease of 11 per cent. compared with slashing. These differences were even more marked during the third year when the yields from the clean-weeded plots were 26 per cent. greater, and those from the 'forestry' plots 14 per cent. less, than those from the slashing treatment.

References.

(1) Haines, W. B. The Uses and Control of Natural Undergrowth on Rubber Estates. Rubber Research Institute of Malaya, Planting Manual No. 6, 1934.

(2) Dennett, J. H. Manurial Experiments on Oil Palm. *Malayan Agricultural Journal*, Vol. XXVI, No. 7, July 1938, page 281.

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RICE IN MALAYA IN 1939

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Prices.

The average wholesale prices of rice per picul in Singapore in 1939 were as follows:—Thailand No. 2 Ordinary $3.98, Rangoon No. 1 $3.62, Saigon No. 1 $3.47. Of the net imports during the year 67.8 per cent. were from Thailand, 25.5 per cent. from Burma, 5.1 per cent. from French Indo-China, and 1.6 per cent. from other countries.

The average declared trade value of imports during the year was $3.75 per picul, as compared with $3.93 in 1938.

Retail prices of rice remained on about the same level as in 1938. The average retail prices for 1939 in cents per gantang of No. 2 Thailand rice were as follows:—Singapore 27, Penang 31, Malacca 29, as compared with 28, 32 and 28 in 1938 and 30, 36 and 32 respectively in 1937.

During the latter part of the year the prices of all grades of rice, both wholesale and retail, were controlled by the Government.

The details of wholesale and retail prices are given in Table I.

Table I.
Average Prices of Rice in Malaya in 1939.

Month	Wholesale Prices of Rice Dollars per picul (133 1/3 lbs.)			Retail Prices of Rice Cents per gantang (gallon)			Price of Padi per Picul at Government Rice Mills, Perak.
	Thailand No. 2 (Ordinary)	Rangoon No. 1	Saigon No. 1 (Long Grain)	Singapore	Penang	Malacca	
January ...	4.22	2.92	3.30	27	32	30	2.10
February ...	4.05	3.07	3.27	27	32	30	2.00
March ...	4.06	3.17	3.47	26	32	28	2.05
April ...	3.71	3.17	3.42	26	32	28	2.20
May ...	3.81	3.22	3.47	27	32	28	2.20
June ...	3.75	3.40	3.35	26	32	28	2.25
July ...	3.64	3.55	3.37	26	31	28	2.20
August ...	3.72	3.55	3.25	24	30	28	2.20
September ...	4.12	4.10	3.72	29	30	30	2.20
October ...	4.15	4.35	3.65	30	30	30	2.20
November ...	4.05	4.35	3.50	30	30	30	2.20
December ...	4.43	4.52	3.92	28	29	30	2.20
Average 1939	3.98	3.62	3.47	27	31	29	2.17
Average 1938	4.26	3.74	3.94	28	32	28	2.14
Average 1937	4.39	3.75	3.92	30	36	32	1.99
Average 1936	3.86	3.44	3.59	28	29	26	1.91

Imports and Exports.

A statement of annual imports and exports, with values for the past eleven years, is given in Table II. The net imports of rice in 1939 were 658,653 tons, of which 430,228 tons were from Thailand, 184,880 tons from Burma, 32,203 tons from French Indo-China, and 11,342 tons from other countries. In 1938 net imports were 612,394 tons, of which 376,635 tons were from Thailand, 208,690 tons from Burma, 15,692 tons from French Indo-China, and 11,377 tons from other countries.

Table II.

Rice: Malayan Imports and Exports.

Year	Imports		Exports		Net Imports	
	Tons	Value $	Tons	Value $	Tons	Value $
1929 ...	785,558	95,461,036	233,897	28,031,407	551,661	67,429,629
1930 ...	800,443	87,666,723	208,688	23,361,561	591,755	64,305,162
1931 ...	691,112	48,458,102	175,385	13,453,189	515,727	35,004,913
1932 ...	592,209	39,632,925	183,209	12,660,493	409,000	26,972,432
1933 ...	592,912	33,846,158	159,746	9,193,291	433,166	24,352,867
1934 ...	619,199	32,813,558	165,968	8,609,566	453,231	24,203,992
1935 ...	655,845	40,114,794	184,463	11,060,993	471,382	29,053,801
1936 ...	715,632	43,053,805	181,837	10,846,378	533,795	32,207,427
1937 ...	711,581	47,800,364	138,518	9,589,376	573,063	38,210,988
1938 ...	814,870	53,822,372	202,476	13,389,308	612,394	40,433,064
1939 ...	824,126	51,931,238	165,473	10,230,494	658,653	41,700,744

The different grades of rice products imported during 1939 were as follows (net imports only are given):—cargo rice 38,208 tons, parboiled 71,209 tons, white rice 460,145 tons, broken rice 89,091 tons, as compared with 33,319, 69,337, 430,494 and 79,244 tons respectively in 1938.

The total quantity of rice products imported for local consumption in 1939, including rice bran and rice meal of which 166,247 tons, valued at $4,932,097 were imported for consumption locally, amounted to 824,900 tons, valued at $46,632,841, as compared with 767,462 tons, valued at $45,452,333 in 1938. The net imports of padi, which amounted to 51,912 tons, valued at $2,364,629 are not included in the above figures. Net imports of padi in 1938 were 4,791 tons, valued at $191,023.

Areas and Yields.*

The area planted with "wet" padi in the season 1938-39 was 704,390 acres, and constituted a new high record, the previous record being 691,110 acres in the season 1933-34. The area planted in the season 1937-38 was 682,120 acres. In

* Estimating the area and yields of padi presents great difficulty, and the following figures are therefore given with due reservations.

the Federated Malay States the area increased by 6,430 acres to a total of 181,350 acres, due to new areas being opened up in Perak and Selangor. The planted area in the Straits Settlements did not differ materially from that of previous years.

In the Unfederated Malay States the Kedah area showed the greatest increase, the total area being 256,350 acres as compared with 245,700 acres. Johore and Perlis showed slightly increased areas, but the Trengganu area declined slightly. Brunei, with 3,470 acres appears in these returns for the first time.

The total area planted with "dry" padi increased by a little more than 4,000 acres, due largely to an increase in Perak.

Table III.
Areas and Yields of Padi.

Year	"Wet" Padi			"Dry" Padi			Total	
	Area Acres	Yield Gantangs	Gantangs per Acre	Area Acres	Yield Gantangs	Gantangs per Acre	Area Acres	Yield Gantangs
1929 - 30	629,650	103,624,000	164	27,550	3,160,000	114	657,200	106,784,000
1930 - 31	603,070	166,845,000	277	104,670	9,122,000	87	707,740	175,967,000
1931 - 32	635,130	184,631,000	291	89,850	12,472,000	139	724,980	197,103,000
1932 - 33	674,920	186,345,000	276	91,990	13,416,000	146	766,910	199,761,000
1933 - 34	691,110	215,098,000	311	74,140	9,389,000	127	765,250	224,487,000
1934 - 35	669,290	213,835,000	319	65,440	6,720,000	106	734,730	220,555,000
1935 - 36	674,900	219,786,000	325	50,150	8,087,000	161	725,050	227,873,000
1936 - 37	693,550	206,256,000	297	46,490	6,354,000	137	740,040	212,610,000
1937 - 38	682,120	193,240,000	283	44,550	6,020,000	135	726,670	199,260,000
1938 - 39	704,390	218,604,000	313	48,850	8,805,000	180	753,240	227,409,000

(Acreage to nearest 10 acres: yields to nearest 1,000 gantangs)

The production of "wet" padi in the season 1938-39 was 218,604,000 gantangs (gallons), an increase of 25,364,000 gantangs over the previous year and 12,348,000 gantangs over the season 1936-37.

Even admitting the liability to error in arriving at figures of yield of a padi crop, the increase is sufficiently marked to justify the statement that the yield per acre, especially in the more important centres of production, was very favourable in the season under review. The increased yield is also due in part, of course, to the larger area planted this season. Considerably increased crops were obtained in Perak, Province Wellesley, Kedah and Perlis. The Pahang area and crop showed a decrease, as did also Malacca and Trengganu, but these decreases were relatively unimportant.

Table IV.
Area of Land Planted in Malaya and Yields of Padi Season 1938—1939.

Territory	Wet		Dry		Total	
	Acres	Gantangs	Acres	Gantangs	Acres	Gantangs
F.M.S. :—						
Perak ...	94,310	29,575,000	3,870	519,000	98,180	30,094,000
Selangor ...	16,600	3,824,000	230	48,000	16,830	3,872,000
Negri Sembilan ...	34,730	9,890,000	70	8,000	34,800	9,898,000
Pahang ...	35,710	6,602,000	960	161,000	36,670	6,763,000
Total ...	181,350	49,891,000	5,130	736,000	186,480	50,627,000
S.S. :—						
P. Wellesley ...	33,270	11,600,000	200	42,000	33,470	11,642,000
Penang ...	2,950	1,337,000	—	—	2,950	1,337,000
Malacca ...	31,840	11,529,000	—	—	31,840	11,529,000
Labuan ...	650	145,000	—	—	650	145,000
Total ...	68,710	24,611,000	200	42,000	68,910	24,653,000
U.M.S. :—						
Johore ...	7,950	1,368,000	690	60,000	8,640	1,428,000
Kedah ...	256,350	100,072,000	2,000	411,000	258,350	100,483,000
Perlis ...	40,050	12,555,000	—	—	40,050	12,555,000
Kelantan ...	114,810	25,895,000	30,340	5,046,000	145,150	30,941,000
Trengganu ...	31,700	3,043,000	8,090	1,810,000	39,790	4,853,000
Brunei ...	3,470	1,169,000	2,400	700,000	5,870	1,869,000
Total ...	454,330	144,102,000	43,520	8,027,000	497,850	152,129,000
TOTAL MALAYA ...	704,390	218,604,000	48,850	8,805,000	753,240	227,409,000

Note :—Acreage to the nearest 10 acres. Yield to the nearest 1,000 gantangs.

In the Federated Malay States the total crop harvested, 50,627,000 gantangs, was 5,216,000 gantangs greater than in 1937-38; in the Straits Settlements 24,653,000 gantangs, or 2,107,000 gantangs greater, and in the Unfederated Malay States 152,129,000 gantangs or 20,826,000 gantangs greater than 1937-38. Of this increased crop Kedah contributed 17,775,000 gantangs.

Table V.

Area of Land Planted in Malaya and Yield of Rice.

Season	F.M.S.		S.S.		U.M.S.		Total	
	Area Acres	Production Rice Tons	Area Acres	Production Rice Tons	Area Acres	Production Rice Tons	Area Acres	Production Rice Tons
1929 - 30	174,466	55,577	67,005	25,944	415,727	78,815	657,198	160,335
1930 - 31	178,930	57,027	67,350	39,503	461,460	167,672	707,740	264,202
1931 - 32	194,580	67,658	67,980	39,626	462,420	188,664	724,980	295,948
1932 - 33	214,160	76,331	70,530	36,051	482,220	187,539	766,910	299,921
1933 - 34	195,690	78,835	70,550	44,180	499,010	214,053	765,250	337,068
1934 - 35	176,750	79,559	68,500	43,988	489,480	207,617	734,730	331,164
1935 - 36	178,020	78,011	67,750	37,818	479,280	226,321	725,050	342,150
1936 - 37	185,730	80,872	69,090	37,622	485,220	200,740	740,040	319,234
1937 - 38	176,880	68,185	67,650	33,853	482,140	197,152	726,670	299,190
1938 - 39	186,480	76,016	68,910	37,017	497,850	228,422	753,240	341,455

(Yield estimated on a basis of 666 gantangs of padi = 1 ton of rice)

Consumption Compared with Production and Imports.

As will be seen from Table VI, Malaya produced but 34 per cent. of her requirements of rice in 1939. Production reached the record high level of 341,455 tons; net imports also reached a record high level of 658,653 tons; consumption therefore was, for the first time, over the million ton mark. It is probable that this figure is not quite a true one inasmuch as part of the local crop, being a bumper one, will remain in store to equalize possible smaller crops in the following year, and on account of the outbreak of war rice and padi were imported to increase stocks and for storage.

The fact remains, however, that despite continual and steady rise in production, Malaya has been unable materially to increase the percentage of local production to total consumption. Twenty years ago production was only 188,000 tons of rice, and net imports 370,000 tons. The percentage of local production to total consumption was therefore identical with that of 1939 when production was 80 per cent. greater, but when imports had increased by about 77 per cent.

Table VI.
Malayan Production of Rice in Relation to Net Imports and Consumption 1930—1939.

	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
Net imports (tons)	591,755	515,727	409,000	433,166	453,229	474,955	533,795	573,063	612,394	658,653
Production (tons)	160,335	264,202	295,948	299,921	337,068	331,164	342,150	319,234	299,190	341,455
Consumption (tons)	752,090	779,929	704,948	733,087	790,297	806,119	875,945	892,297	911,584	1,000,108
Percentage of production to net imports	27	51	72	69	74	69	64	56	49	52
Percentage of production to consumption	21	34	42	41	43	41	39	36	33	34

Prospects for the 1939-40 Season.

The prospects of the 1939-40 season in the main area of production were reviewed at the end of 1939.

The most important areas of production are situated in the States of Kedah, Kelantan and Perak, about 65 per cent. of the area under "wet" padi being in these States.

Dry weather in parts of Kedah has adversely affected the crop and may result in a smaller yield per acre this year. On the other hand, the reduction may be counterbalanced by an increased acreage. Taking a conservative attitude the total yield may not be much reduced from that of average years although it may be less than the figure for last year.

In Kelantan, monsoon rains were late; this delayed the planting of the long-term varieties of padi. Cultivators as a whole have made a greater effort this season than normally and much improvement in such matters as the conservation of water has been noticed as well as a pronounced increase in the area planted. A further report in January 1940 states that the situation has worsened in January due to drought and pests and it is reported that the crop may be down by 10 per cent. on last season.

The reports from the important area in Krian, Perak, are encouraging. Due to good water conditions during planting and to an increase of 2,000 acres in the planted area, the total crop may be at least 10 per cent. greater than that of last season. Elsewhere in Perak increased crops are expected.

Malacca reports indicate that there may be a drop of 50 per cent. compared with that of the 1938-39 season. Drought conditions have resulted in entire crop failure over large areas.

The Negri Sembilan crop may be from 5 to 10 per cent. lower than last season. In many instances the standing crop shows every indication of being above average, but there are considerable areas which have not been planted this season, and the increased crops from good areas are likely to counterbalance these failures which, like Malacca, were due to drought.

It is estimated that the crop from Province Wellesley and Penang will be about 7½ per cent. below the figure for last year.

Padi planting is not extensive in Johore. The acreage planted is expected to be about 12,000 acres as against 7,950 acres last season. Owing to unfavourable weather conditions yield per acre will not be good, but in view of the increased acreage, the total crop may be as much as 25 per cent. greater than that of last season.

Pahang reports an increased acreage planted and a favourable season so that the crop will certainly be 10 per cent. and may be 15 per cent. greater than in the last season.

A very unfavourable season, due to drought, was experienced in Selangor and the crop is expected to be only 57 per cent. of that of the season 1938-39.

Summing up the various reports, while it is anticipated that the total Malayan crop will be lower than in the previous season, it can safely be assumed that it will not be more than 7 per cent. below last year's total, and indeed the deficiency may not be as great.

Milling.

There are two Government Rice Mills in the Krian District of Perak, and one at Temerloh, Pahang. The Krian mills purchased a total of 19,290 tons of padi, and produced 71,169 bags of rice of 170 kati, of which 39,730 bags were under-milled and white rice, and 31,439 bags parboiled rice. The Temerloh mill purchased a total of 334 tons of padi during the year, which constituted a record.

More small power-driven rice mills have been erected, and in Perak the number of such mills increased from 10 in 1938 to 38 in 1939. In Province Wellesley, in addition to the old-established large mills, the number of these small mills has further increased from 7 to 15. In Kelantan the Tumpat mill was unable to obtain adequate supplies of padi, the peasants preferring to dispose of any surplus in small quantities by sale or barter at the local fairs instead of by selling in bulk to the mill. There are now reported to be 89 rice mills in Kedah, most of which are power driven; 15 of these mills have a capacity of over 100 bags of rice per 12 hour day.

Acknowledgments.

The Field Branch of the Department of Agriculture, in collaboration with the Land Officers and in some cases with the Drainage and Irrigation Department, is responsible for the estimates of areas and yields summarized in Table V. The figures for imports and exports and relative values are obtained from Malayan Statistics, published by the Statistics Department, S.S. and F.M.S.

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MANURIAL EXPERIMENTS WITH GUINEA GRASS AT THE CENTRAL EXPERIMENT STATION, SERDANG

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Introductory.

An account was given in a previous number of this Journal(1) of two main experiments carried out with the manuring of Guinea grass at the Central Experiment Station, Serdang.

The present article deals with further results obtained in the second main experiment. While this experiment was designed primarily to test different planting distances in respect of yield of grass, subsidiary objects were to ascertain whether higher yields could be obtained on low-lying land, also whether the comparative ineffectiveness of cattle manure in maintenance of yield found in the first experiment would be repeated on this particular type of land.

Summary of Previous Work.

The following is a brief summary of the results obtained up to the commencement of the experiment now under discussion.

The grass was planted towards the end of 1934. The lay-out was in the form of a four-way Latin Square with plots of 1/10th acre. Planting distances were 3 ft. x 3 ft. (4,840 plants per acre), 4 ft. x 2 ft. (5,445 plants per acre), 3 ft. x 2 ft. (7,260 plants per acre), and 2 ft. x 2 ft. (10,890 plants per acre). The columns were split into alternate strips receiving cattle manure at the rate of 10 tons per acre per annum and basic slag at the rate of 750 lbs. per acre per annum. Cutting at a uniform monthly rate commenced in January, 1935.

High yields of grass were obtained during the first few months. The average monthly figures based on the first three months of cutting amounted to 298 lbs. and 316 lbs. of grass per acre per day for cattle manure and basic slag respectively. By June, 1936, the average monthly yields based on the previous three months cutting had dropped to 85 lbs. and 58 lbs. of grass per acre per day for the respective treatments. The first sign of any differential response in favour of the cattle manure was observed after 15 months.

No differences in yield were obtained between grass planted at varying distances.

As a result of the greatly diminished yields it was decided to increase the quantity of cattle manure to 15 tons per acre per annum and to test the effect of nitrogen and potash. To give effect to this all plots treated with basic slag received nitrogenous fertilizers and half the plots potash in addition, while half the plots treated with cattle manure also received potash. The original paper should be consulted for details of the various dressings.

Cutting at a uniform monthly rate was continued for a further 18 months. The results in the second phase showed that the increased application of cattle manure, irrespective of potash, raised yields to a figure of approximately 100 lbs. of grass per acre per day, equivalent to about 16 tons per acre per annum. Artificial fertilizers merely maintained yields at the previous low level of about 60 lbs. of grass per acre per day, equivalent to about 9.5 tons per acre per annum.

Once again no differences in yield were observed between grass at varying planting distances.

Third Phase of Experiment.

In the third phase of the experiment, which will now be described, the application of artificial fertilizers was abandoned; increased amounts of cattle manure were applied, the rates being 15, 20, 25 and 30 tons per acre per annum respectively.

It is realized that with land yielding only 100 lbs. of grass per acre per day applications of cattle manure in excess of 15 tons per acre per annum are uneconomic. Taking a daily ration of 40 lbs. of grass per animal (Indian breed) 100 lbs. of grass will be sufficient for 2.5 animals. If production of manure, including bedding, is taken at 40 lbs. per day the maximum manure available for application from this number of animals is about 16 tons per annum. The main object in this phase of the experiment was, however, to ascertain whether there was a limit to the yield of grass on a particular type of land irrespective of the amount of cattle manure applied.

The half-plot arrangement devised in the second phase of the experiment by which each plot of 1/10th acre was divided into two sub-plots of 1/20th acre each was maintained. The lay-out is shown in Diagram I. As will be seen from the diagram each manurial treatment was repeated eight times. The planting distances remained unaltered, each distance being repeated four times.

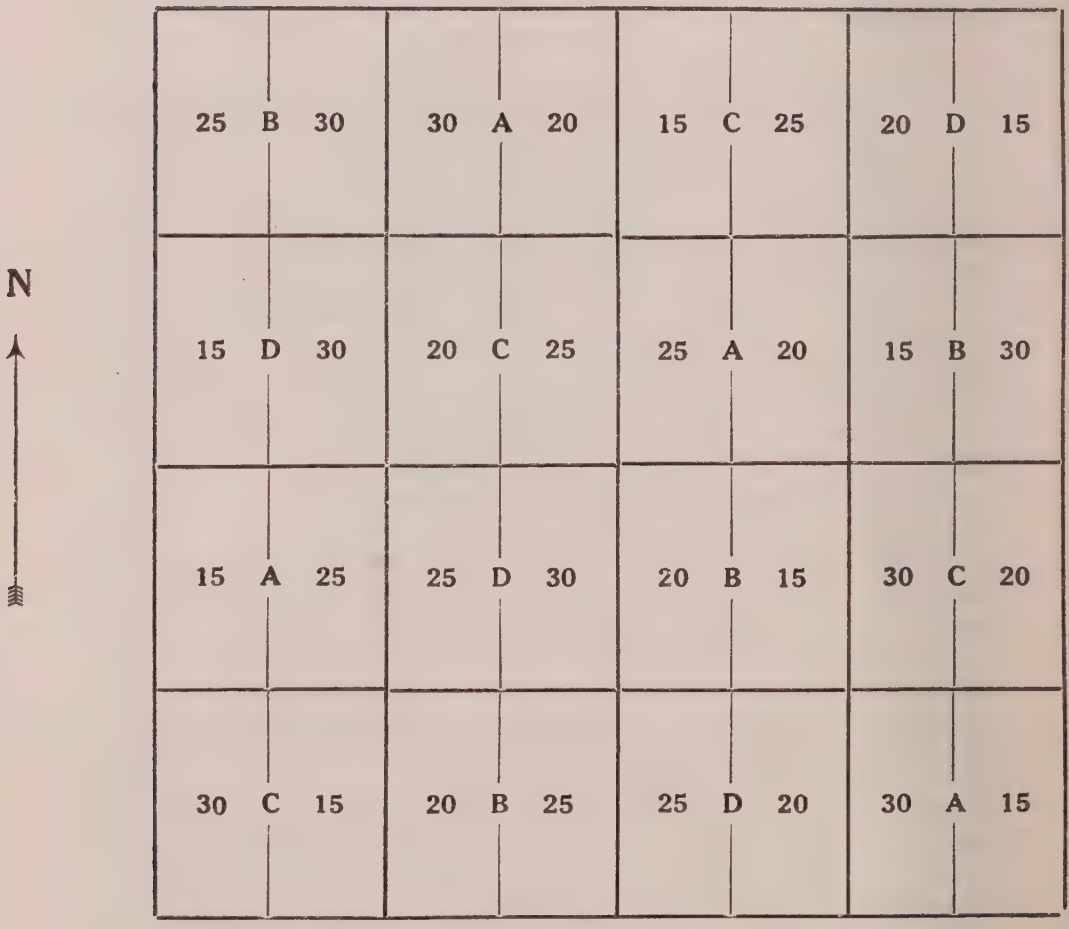
The lay-out was no longer a Latin Square as originally designed. The rows were balanced but not the columns. While it would have been possible to have arranged for a simpler lay-out consisting of 16 plots, such an arrangement would not have enabled possible interaction between planting distance and heavy manuring to have been demonstrated if present.

Half the annual application of cattle manure was applied in February, 1938, after which the area was rested from March to May in order to restore vigour to the plants. Cutting at a uniform monthly rate was resumed in May, 1938.

Further applications of cattle manure at half the annual rates were made in August, 1938, and March, 1939. The method of application was to apply the manure in trenches about 6 ins. deep and about 1 ft. wide. The trenches were dug north and south between alternate rows of the grass, commencing from the west side of each plot between the first two rows of grass. The calculated amount of manure was spread evenly along the trench and the soil replaced on top.

Diagram I.

Arrangement of Plots in Third Phase of Second Manurial Experiment with Guinea Grass in Field 41 at Serdang.



Notes:—1. The letters refer to the different planting distances for the grass.

A. 4 ft. x 2 ft.
B. 3 ft. x 2 ft.
C. 2 ft. x 2 ft.
D. 3 ft. x 3 ft.

2. The numbers refer to the annual rates of application of cattle manure, which were 15, 20, 25, and 30 tons per acre per annum respectively.

Table I.

Average Yields of Guinea Grass in Third Phase of Second Manurial Experiment in Field 41 at Serdang.

(Results calculated in lbs. of grass per acre per day).

Annual Rate of Application of Cattle Manure in tons per acre	First Period May—November, 1938					Second Period November, 1938—May, 1939					Third Period May—November, 1939				
	A	B	C	D	Mean	A	B	C	D	Mean	A	B	C	D	Mean
15 ...	178	169	169	153	167	100	109	98	102	102	98	94	97	94	96
20 ...	159	183	167	186	174	107	95	104	107	103	94	93	95	92	93
25 ...	174	179	174	182	177	99	95	104	103	100	96	98	94	90	94
30 ...	205	187	238	152	196	107	103	98	96	101	96	98	100	98	98
Mean ...	179	179	187	168	178	103	101	101	102	102	96	96	96	93	96

Note:—The letters A, B, C, and D refer to planting distances for the grass.

A. 4 ft. x 2 ft.
B. 3 ft. x 2 ft.
C. 2 ft. x 2 ft.
D. 3 ft. x 3 ft.

Yields of Grass.

Table I gives the figures for the yields of grass for the three six-monthly periods commencing May, 1938.

The results indicate that during the period of the experiment the average yield of grass decreased from 178 to 96 lbs. per acre per day. In this connexion it is interesting to note that the latter figure is of approximately the same order as that obtained from the plots treated with cattle manure in the last six months of the second phase of the experiment. In that case the average figure was 108 lbs. of grass per acre per day.

The figures in this phase of the experiment have not been statistically analysed since inspection shows no significant differences between yields of grass planted at varying distances or between yields obtained from increasing applications of cattle manure.

Discussion.

Table II gives a summary of the figures for the average six-monthly yields of grass from the plots treated with cattle manure at the rate of 15 tons per acre per annum in both the second and third phases of the experiment.

Table II.

Comparative Yields of Guinea Grass from Plots Treated with 15 Tons of Cattle Manure in Second and Third Phases of Second Manurial Experiment in Field 41 at Serdang.

(Results calculated in lbs. of grass per acre per day).

Second Phase			Third Phase		
Details of Six-monthly Period.	Age of Grass during Period	Yield of Grass	Details of Six-monthly Period.	Age of Grass during Period	Yield of Grass
	years			years	
July-December, 1936	1¾ - 2¼	89	May-November, 1938	3½ - 4	167
January-June, 1937	2¼ - 2¾	107	November, 1938 - May, 1939	4 - 4½	102
July-December, 1937	2¾ - 3¼	108	May-November, 1938	4½ - 5	96

Apart from the increased yield obtained during the period May to November, 1938, which it is considered may be accounted for by the 2 months resting period before cutting and possibly by slight residual manurial effects from the previous treatments, the results appear to indicate that with flat land of medium texture there are limits to the yield of grass which can be expected and to the amount of cattle manure which can be profitably employed thereon. This experiment shows the figures to be of the order of 100 lbs. of grass per acre per day and 15 tons of cattle manure per acre per annum respectively.

Summary.

The results of the experimental work in the third phase of this experiment may be summarized as follows:—

(i) Applications of cattle manure above the economic limit when applied to Guinea grass on flat land of medium texture have not resulted in any significant increase in yield.

(ii) The possibility of a limit for the yield of grass for a particular type of soil irrespective of the rate of application of manure applied is discussed.

(iii) There would appear to be no correlation between yields of grass and planting distances within the limits of 4,840 and 10,890 plants per acre.

Acknowledgment.

The writer wishes to acknowledge the assistance of Mr. P. V. Ormston and Dr. W. N. Scott, Agricultural Officers, during the initial stages of the experimental work.

References.

1. Experiments with Guinea Grass at the Central Experiment Station, Serdang. *Malayan Agricultural Journal,* Vol. XXVI, No. 6, June 1938, page 224.

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THE EFFECT OF SODIUM ARSENITE APPLIED TO CONTROL WEED-GROWTH AMONG COCONUT PALMS

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The following note has been prepared in response to enquiries which are received from time to time regarding the possibilities of any harmful effects following the application of sodium arsenite to control *lalang* and other noxious weed growths among coconut palms.

There are three possibilities to be considered: (a) a toxic effect on the soil, (b) an adverse effect on the growth of the palm, and (c) absorption of arsenic by the palm to the extent of rendering the copra harmful to human beings and animals as a result of deposition occurring in the endosperm.

With regard to the question of a toxic effect on the soil, attention is drawn to a comprehensive investigation carried out at the Central Experiment Station, Serdang, regarding the control of *lalang* by means of sodium arsenite(1). The results showed that this chemical, when applied at the rate of 100 lbs. per acre (10 applications, each of 10 lbs.), did not appear to have a toxic effect on the soil or on plants growing in the same area when the sodium arsenite was not directly applied to their foliage.

An experiment has been carried out at the Coconut Experiment Station, Port Swettenham, to determine the effect on the coconut palm and the extent to which the copra might be affected.

The ground for a radius of 15 ft. around a mature coconut palm was sprayed at weekly intervals for 11 weeks with 1 gallon of a solution made up by dissolving 3.2 ozs. of sodium arsenite in that volume of water.

Assuming the palms to be planted 30 ft. x 30 ft. triangular (55 palms per acre) the total application of sodium arsenite amounts to 121 lbs. per acre. This is a somewhat heavier application than that used in the *lalang* experiments at Serdang.

As a result of the treatment the grass turned completely brown; the palm appeared to be unaffected and there was no change in the colour of the leaves.

The grass around the palm had become re-established after a period of 3 to 6 months from the date of the last application, thereby confirming the absence of any permanent toxic effect on the soil.

Commencing with the date of the last application of sodium arsenite two coconuts were forwarded at monthly intervals for a period of 6 months to determine the arsenic content of the fresh meat.

The results of analysis showed that only minute traces of arsenic were likely to be found in the meat of the nuts. For example, in the case of the two nuts forwarded 5 months after the last application the amounts of arsenic, calculated

as arsenious oxide (As_2O_3) were found to be 0.00004 and 0.00006 per cent, respectively. Assuming the amount of a lethal dose of arsenious oxide to be about 4 grains, the above figures indicate that the consumption by one adult of 1,400 or 1,500 nuts would be required to produce fatal results!

In order to ascertain whether there was any likelihood of very immature nuts at the time of application or nuts formed subsequent to that date being affected as a result of the treatment further samples of nuts were examined after the lapse of 12 months and 18 months respectively. The amounts of arsenic present were of the same order as those previously found.

It may be concluded, therefore, that no danger is likely to arise from consumption of nuts growing on land sprayed with sodium arsenite up to the rate of application indicated.

Reference.

1. Greig, J. L. The Use of Chemicals for Eradication of *Lalang* Grass, *Malayan Agricultural Journal*, Vol. XXV, No. 9, September 1937, page 363.

Received for publication, 25th January, 1940.

QUARTERLY REPORT ON THE MALAYAN PINEAPPLE CANNING INDUSTRY.

December, 1939, to February, 1940.

Prepared by the Economics Branch of the Department of Agriculture, S.S. & F.M.S., from Reports of Field Officers.

Factories.

The total number of registered factories, including four peeling sheds, remains unchanged at twenty, distributed as follows:—Singapore 5, Johore 12 and Selangor 3. The registration of one Johore factory together with its "mark" was cancelled on 5th February. Of the sixteen factories proper, all five Singapore factories were in operation throughout the quarter, except during the period of the strike referred to below, and when no fruit was available in the first half of February. In Johore, during December and the first half of January four factories were in operation with increasing supplies of fruit becoming available. Two of these factories were, however, forced to close down on 13th and 15th January respectively, owing to strikes. An agreement with strikers was reached on 5th February, but by this time fruit supplies were scarce and only one factory remained in operation. One factory in Selangor was working until 25th February.

Prices.

There was no change in Singapore for either the canned product or fruit at the factory. Growers complained that prices in the field were still not high enough. Prices of canned fruit in Singapore in Straits dollars per case of 48 cans of 1½ lbs. each were, therefore, as follows:—

	General Average Quality. (G.A.Q.)	Golden
	$	$
Sliced Flat	4.80	5.40
Sliced Tall	4.95	5.55
Cubes	4.85	5.45

The Central Board has fixed prices to be paid at factories for fresh fruit according to the following table:—

Class of Fruit	Average Weight of 100 Fruit	Price for every 100 Fruit less than Half-Ripe			Premium for every 100 Fruit at least Half-Ripe
		Johore and Klang	Singapore		
			Kranji	Serangoon Grove Road	
	lbs.	$	$	$	cents
Under 1½ lbs. ...	125	0.53	0.59	0.62	nil
1½ lbs. to 2½ lbs. ...	200	1.01	1.12	1.17	10
2½ lbs. to 3½ lbs. ...	300	1.52	1.68½	1.77	20
Over 3½ lbs. ...	400	2.03	2.25	2.37	40

Prices paid in the field in Johore vary between 25 cents and $1.90 per 100 fruits. The average price, however, would appear to be between 50 and 60 cents per 100 fruits. Prices paid were influenced by the disorganization caused by the factory strike.

Production and Sales.

The quota fixed by the Central Board for the small season September to February was 950,000 cases. Owing to the strike, difficulties were experienced for a time in effecting factory deliveries under contracts.

Exports of Malayan pineapples for the three months subsequent to the last quarterly report were as follows:—November 3,722 tons, December 3,957 tons, January, 1940, 5,583 tons.

The Strike.

Immediately after the outbreak of war and before the strike took place, at the suggestion of the Central Board owners of each pineapple factory had announced an increase of wages at the rate of 5 per cent., and this rate was subsequently increased to 10 per cent.

On 8th January the labourers at four Singapore factories went on strike, and the strike spread to Johore. The strikers' demands were for a 20 per cent. increase in wages, with a higher increase for cutters. After prolonged negotiations the strike was eventually settled on 5th February with an all-round 15 per cent. increase in wages.

The strike came just in the middle of the small season crop. Certain factories were left full of cut fruit and refuse which the labourers refused to clear up and which were eventually cleared away by Municipal labour. The loss to growers was very serious, it being estimated that Johore growers suffered a loss of about $6,000 daily during the strike.

Government Research Station and Canning Factory.

Trial inspections have been made under the Malayan Mark Pineapple Regulations (Grading and Marking) of 1938. The object of these trial examinations was to obtain a scale of exact definitions of quality so that all samples can be rigidly assessed on a prescribed basis.

It is proposed to allow a probationary period during which the system of examination can be amended and improved if necessary. Reports with recommendations are to be issued regularly to all factories from which samples are collected so that the standard of production in each factory can gradually be raised to the level required, before the Enactment is legally enforced.

The value of external lacquers as a protective coating to cans has been studied. It is found that these lacquers give a high measure of protection except when cases of canned fruit are subjected to exceptionally drastic treatment.

An interesting series of processing trials has confirmed the value of the exhaust process and, under existing Malayan methods of canning, of the importance of adding the syrup hot to the cans of fruit if a satisfactory vacuum is to be obtained. Examination of canned pineapples subjected to various temperatures has shown that the vacuum is improved with a reduction in temperature until the contents freeze, when, owing to the resulting expansion, the vacuum is destroyed. If the vacuum is unsatisfactory, pressure will develop in the cans at the high temperature experienced in the holds of ships, and "flippers" will result.

General.

It is expected that the next main crop will be rather later than usual. At the end of the quarter practically no supplies of fruit were available in Johore. The big season crop was developing well, but it is unlikely that fruit in large quantities will be available before the end of March. It is not yet possible to forecast the effect, if any, of the recent drought conditions. Crop prospects in Selangor are reported to be poor.

Selected Article.

THE STORAGE OF FOODSTUFFS IN THE COLONIAL EMPIRE *

(*Continued*)

The Control of Insect Pests.

The main measures available for the protection of foodstuffs in store are fumigation, the use of insecticidal dusts, and perhaps the use of sticky substances to prevent the insects wandering.

Fumigation.

In spite of extensive fumigation carried out in certain countries, the general principles underlying the use of fumigation are still insufficiently appreciated, and the Department of Scientific and Industrial Research has recently thought it necessary to have prepared a pamphlet dealing with the principles of fumigation, from which some of the information given below has been taken prior to publication by permission of the Department.([11]).

The first need in fumigation is the complete vaporization of the fumigant, but in warm countries this difficulty is not likely to arise. The most important cause of failure is the large amount of gas which is liable to be rendered inactive because of its absorption. This may take place on the walls of the fumigation chamber itself, on the surface of the bags, cases or boxes containing the produce, and on the surface of the produce. In consequence, ample allowance should be made for absorption of fumigant, while any fumigant so absorbed must be regarded as having little or no insecticidal effect. Further, on account of absorption of the gas by the product, the concentration of the fumigant varies inversely with the depth below the surface. Downward diffusion, therefore, does not depend entirely on whether the vapours of the fumigant are heavier than air, and it is essential to apply a dosage strong enough to provide a toxic concentration after the product has taken up all it can. Various products differ in their ability to absorb fumigants. Those rich in fat, such as nuts, absorb a high percentage of gas, and grain very little. Dry food will take up only traces of most gases. Accordingly, longer aeration is necessary after fumigation in the case of foods rich in fat. The concentration and the time during which a fumigant acts influence the depth of penetration of a gas. Therefore, a small dosage of a fumigant for a long time is as effective as a large dosage for a short time.

A further cause of ineffective fumigation lies in the unsuitable piling or stacking of the goods to be treated, and it is necessary that in such cases goods shall be stacked so as to attain the maximum exposure to the fumigant. It has been found,

* An article prepared by the Agricultural Advisers to the Secretary of State for the Colonies, with assistance from the Imperial Institute, Sir Guy Marshall, Director of the Imperial Institute of Entomology, and Professor J. W. Munro, Director of the Biological Field Station (Stored Products Research), Slough.

The first half of this article appeared in the March issue of *The Malayan Agricultural Journal.*

for example, in experiments with cacao in bags laid horizontally that one end of every bag should be exposed. Penetration is affected also by the size and disposition of the "intergranular spaces," *i.e.* the small spaces between the grains or beans. The proportion of these spaces varies greatly in different products, but is often surprisingly high. Effective circulation and distribution of a fumigant can often be attained by quite simple means; for example, by the use of large fans or punkahs slung from the roof of the chamber or building and operated from outside by means of a rope or cord.

In general, the important points to observe are that adequate dosage must be given to allow for loss by absorption and leakage, and adequate provision made for effective circulation of the fumigant throughout the goods.

One difficulty in effective fumigation is that it usually results in the absorption and retention of quantities of the fumigant in the goods treated. But this is only a drawback in that it prolongs the period of ventilation of the goods necessary before they are handled or consumed. Even with hydrogen cyanide, which is one of the most penetrating of all the fumigants, "residual" gas can in most products be eliminated by the simple process of ventilation or airing the goods.

Certain goods are quite unsuitable for treatment by fumigation, especially those rich in essential oils, *e.g.*, cloves. But except in special instances, effective ventilation is a fairly reliable safeguard against residual fumigant.

Construction of Buildings and Containers used for Fumigation.

The first requirement for efficient fumigation is a building or container that can be made as airtight as possible, so that the fumigant shall remain in all parts of the space at full strength and for the required time. Loss of fumigant may arise from leakage and from absorption in the materials of construction. In brick and concrete buildings in good repair the absorption loss is the more important, and the total loss may be such as to render these buildings unsatisfactory for the routine fumigation of goods. Absorption can, however, be greatly reduced by painting exposed surfaces of absorbent material with oil paint, or with cellulose paint, but not with whitewash or distemper. Wood, brick, concrete, mortar, plaster and composition boards are all strongly absorptive, the capacity varying with the quality of the material, density of concrete, hardness of wood, etc.

Accordingly, wherever possible, goods should be fumigated in specially constructed fumigation chambers, and the cost of handling involved in this procedure is more than offset by its reliability and by a saving in fumigant which is otherwise lost through leakage and absorption. Special chambers have fixed characteristics, so that the standard result is readily obtainable. They can be made of a convenient size and should preferably be fitted with a vaporizer and with means for distributing the gas, and should be adapted to secure rapid ventilation at the end of fumigation. The use of tanks provided with a water seal is especially useful in fumigating with carbon bisulphide. The best practicable material for fumigation chambers is mild steel which is suitable for most fumigants. It is practically non-absorptive and lends

itself to airtight constructions. A cheaper material which is often satisfactory is bituminous felt, supported on a wooden frame secured to a concrete floor. The joints must be made with a bituminous compound and the felt must be protected from mechanical damage and from contact with liquid fumigant, if this has any solvent action. Brick chambers painted with three coats of good oil paint are also satisfactory. When no proper fumigation chamber is available a water-tight barrel covered with double thickness wrapping paper, or an ordinary bin with a properly fitting lid, sealed with paper and paste, may be effectively used for fumigation on a small scale. When no fumigation chamber is available, bags of grain or loose grain may be piled together, covered with a good tarpaulin and then fumigated. These methods give fairly satisfactory results provided the barrel or tarpaulin is gas-tight.

Fumigants Used and Conditions of Fumigation.

In the Colonial Empire the choice of fumigant is restricted, and may be still more restricted in war-time. It is probable that in actual practice only two fumigants need be seriously considered, carbon bisulphide and hydrogen cyanide.

Carbon bisulphide is by far the most commonly used, although its vapours are highly inflammable and explosive when mixed with air in certain proportions; it is also noteworthy that it is not very effective against the eggs of insects and for this reason fumigation, if efficient, should be undertaken twice, the second application being to destroy insects which may have been in the egg stage during the first fumigation. The main advantage of carbon bisulphide is that it can be used in almost any type of chamber or container. Ethylene dichloride is often employed as a substitute for carbon bisulphide when the fire hazard cannot properly be controlled. Its vapour is slightly inflammable, and both it and carbon bisulphide are frequently mixed with 25 per cent. of carbon tetrachloride to reduce the risk of fire. These mixtures are, however, unstable and not satisfactory. Carbon bisulphide is applied by sprinkling evenly over the surface of the grain to be treated by means of a watering can at the rate of from 1 to 3 gallons per 800 bushels of grain, depending upon the temperature of the grain and the tightness of the bin. If the depth of the grain in the bins is more than 5 feet it is advisable to introduce the fluid to below this depth by means of a pipe having openings at frequent intervals along its length. The use of a tarpaulin to cover the grain after the fumigant is applied will help in confining the vapour. Higher concentrations are required if the gas cannot reach the pests so easily.

It seems, however, that under war conditions some difficulty may be experienced in obtaining carbon bisulphide in Colonial dependencies, since the material was usually conveyed only on foreign ships, because charges and conditions of transport on British ships were onerous. It seems certain that they will be still more onerous under war conditions.

An alternative fumigant is hydrogen cyanide. It is one of the oldest, and when properly handled, one of the most efficient. It is, however, very dangerous to man even in small quantities if inhaled and the strictest supervision of its use is

necessary. The original method of using hydrogen cyanide was to generate it by the "pot" method from potassium cyanide and dilute sulphuric acid. This method is still employed, but is not really satisfactory for large-scale work. In temperate countries liquid hydrogen cyanide is now widely used, but it would require special packing under tropical conditions, and its transport is difficult. The most promising form of hydrogen cyanide for tropical use consists of hydrogen cyanide absorbed in some mineral earth or on papier mache discs. Two widely used proprietary brands of hydrogen cyanide are the fumigant known as "Zyklon," originally a German product which consists of hydrogen cyanide absorbed in an inert earth, and "Cyanogas," an American product consisting of a commercial form of calcium cyanide. It is probable that one or other of these brands and papier mache discs may be found most suitable under Colonial conditions. The gas is generated from these by simple exposure to air.

Calcium cyanide may also be employed, and whilst it may have the disadvantage that the gas comes off slowly, this in turn has the advantage that the slow building up of a concentration of gas is less likely to lead to high absorption of the gas by the goods than a rapid building up of a high concentration. The substances above mentioned are easily portable, reasonably easily handled, readily measured out to give the various dosages required, and can be spread out as required to ensure good distribution of gas.

The best method of determining the conditions for fumigation is as follows:—

(1) Make a thorough survey to identify the insects completely and to find out exactly the conditions under which it will be required to kill them.

(2) Find out, by experiment if necessary, the concentration of the selected fumigant and the period of exposure required to kill them.

(3) Find out, by experiment if necessary, the amount of fumigant which must be used and the best method of application so that the requisite concentration shall be maintained at every point, in the warehouse or in the goods, where there may be an insect to be killed.

Sprays.

Many storage buildings, particularly those in tropical countries, are so constructed as to render fumigation difficult. Insect infestation in such buildings is probably best tackled by means of sprays. Insecticidal sprays may be divided into two types; those which rely on a direct hit, whereby the insect is thoroughly wetted, and those which, after atomization, ultimately settle on the insects. It is only in rare circumstances that a direct hit can be obtained on stored products insects and accordingly an atomized spray is essential. A good one consists of an extract of pyrethrum carried in a white oil (Kerosene).

Spraying equipment for this type of spray is available. It requires the use of an air compressor which may be driven by a petrol engine and particulars of the equipment are obtainable from Sterilectric Co. Ltd., and Messrs. Charles Austen & Co., both in London.

Dusts.

It is well known amongst colonial producers that seeds required for planting can be kept effectively free from insect attack if they are stored in vessels or tins with dry wood ashes. Experiments made by Squire in British Guiana have also shown that weevil damage in rice can be materially reduced by the addition of less than 1 per cent. of calcium carbonate (precipitated chalk) and in the Federated Malay States it has been found at the Government Rice Mills in Perak that the treatment of stored rice with 5 per cent. slaked lime affords satisfactory protection from insect attack. In British Honduras it is a common practice to add lime when maize is stored in the cob in heaps or bins, with beneficial results.

In recent years the use of dusts for the protection particularly of grain and cereal products has become more and more general. It is unfortunate that at present no clear understanding of the action of these dusts has yet been attained and there is considerable controversy regarding it. From the practical man's point of view, however, the main point is that these dusts are said to be surprisingly effective and, further, the variety of mineral dusts which are effective is considerable. Of the natural mineral dusts, the best known and probably the most effective is a naturally occurring rock phosphate widely known in Egypt under the name of "Katelsousse." This particular dust has been so generally successful that it is now marketed on behalf of the Egyptian Government by Imperial Chemical Industries Ltd., under that name.

Other effective dusts consist of pure silica, and one of these, known under the proprietary name of "Naaki," has been widely used in Germany and elsewhere. It is a German product and will in consequence not be available during the war. Other simple mineral dusts are precipitated chalk, slate dust and china clay. It is quite probable that a number of naturally occurring earths may prove effective. Some firms market or are about to market dusts for which they claim very high efficiency, and particulars of these can be obtained from Imperial Chemical Industries, Ltd., and Messrs. Peter Spence & Co.

The use of dusts is simple and consists merely in the mixing of the dusts with the grain or other product to be protected. Their general use is for the protection of grain and seeds, particularly pulses. It is worth noting that while experiments on the elimination of these dusts prior to milling and baking of grain are still in progress, the general opinion is that this elimination need present no difficulty, and further that many of the dusts mentioned are innocuous to the alimentary tract. Where dusts such as lime or powdered chalk are used in stored rice their elimination occurs when the rice is washed, as is customary, prior to cooking.

Of all the methods of protecting grain and seeds in particular against insect attack it would seem that the use of dusts is much the most promising.

Sticky Bands.

Many insects which affect stored products may be partially controlled, or may at least have their movements restricted, by the use of sticky substances, applied in a band to the walls or floors of storage buildings. Such substances are similar to those used for banding fruit trees. These sticky bands are of particular use when dealing with migrating caterpillars. They are also of use in isolating infested piles of goods. For such purpose, the bands may be applied to the floor.

It is important to remember that in dusty buildings the surfaces of the bands will rapidly become coated and may thus allow insects to pass over without becoming trapped. Care should be taken to ensure that the sticky surface is maintained in a fresh condition.

Commercial forms of adhesive for grease-banding of trees and banding of warehouse walls are available, but it is quite probable that bird-lime may be readily procured or made. The making and use of it is prohibited in some countries for bird-liming, but doubtless knowledge of its manufacture and use still persists.

The Storage of Root Crops.

The storage of tropical root crops in a fresh condition is a more difficult problem than the storage of grain owing to the large amount of water they contain. There is a marked difference, however, in the case of storage of different kinds of produce. Thus yams are comparatively easily stored, while it is practically impossible to store cassava satisfactorily for any length of time once the roots have been dug.

The most satisfactory method of storage of sweet potatoes and cassava when the preservation of considerable quantities of such products is involved is to slice them and to convert them into dried chips. Slicing into pieces about half an inch thick, with or without peeling, and drying the slices in the sun by exposure on a drying floor is a common practice in parts of Africa. The process presents no difficulty except that the slices require to be protected from rain during drying since if they are wetted they are liable to become leathery and an unsatisfactory product results. Chipped or sliced root crops can be stored in the same way as dried grains and the same precautions require to be observed, as they are equally liable to become damaged by insect attack or mould growth.

Yams.

For storage in a fresh condition it is important that the tubers should be fully ripe before they are lifted. They are ready for digging when the foliage has become dry. So long as dry weather persists the tubers can be left in the ground, as is common in parts of West Africa, and lifted as required for consumption, but the usual practice is to harvest the yam crop as soon as it is ripe. The tubers should be dug very carefully so as to avoid bruising, as bruised tubers do not store well. After lifting, the tubers should be left exposed to the air for a few hours and then stored

on shelves in a well ventilated and cool shaded room or store in layers three or four feet deep. Yams are also stored in carefully packed heaps within weatherproof buildings and sometimes in pits. The latter method cannot, however, be recommended unless the soil is thoroughly dry and likely to remain so.

Buds and eyes should be removed as soon as they show signs of sprouting, while bruised tubers are liable to attack by moulds, and if not removed they should be treated with slaked lime to prevent spread of infection. Under all conditions of storage yams require to be regularly inspected to ensure the removal of all diseased tubers, otherwise infection will spread rapidly, resulting in considerable loss. Under favourable conditions yams can be held in storage for several months, some varieties being much more suitable for lengthy periods of storage than others.

Cassava.

Cassava roots do not store well for any length of time after they have been removed from the ground. Under certain climatic conditions it is dangerous to attempt to do so. The crop can, however, particularly in dry areas, be allowed to remain in the ground for several months before deterioration sets in and the most satisfactory method of storing in a fresh condition is to allow the crop to remain in the ground, digging supplies as required for immediate consumption. Certain varieties of cassava can be left undug for much longer periods than others without undue detriment to the starch content of the tuberous roots.

Cassava lends itself very well to the preparation of dried chips and if for any reason it is impracticable to leave the crop in the ground this is the best procedure. In wet districts or in areas liable to insufficient drainage, cassava cannot be satisfactorily left undug, and if production is in excess of consumption needs, the surplus should be converted into chips or meal. When the chips are required for use they may be pounded and sieved to remove the fibre from the meal.

Cassava meal may also be prepared directly from the fresh cassava, as is the usual practice amongst the Aboriginal Indians in British Guiana and the Mayas in British Honduras. In the former colony, the roots are cleaned and then grated upon what resembles an English grater which has been beaten out flat and nailed to a small piece of board. The resulting meal is then stuffed into a basket-like cylinder which has loops attached to either end. One of these loops is attached to a beam in the house, whilst through the lower loop is passed a stout stick which is pulled upon so that the wicker cylinder, owing to the pressure, gradually become longer and longer. The watery contents so expressed are collected and boiled to form the cassareap which is used for the preservation of meat. The meal remaining in the cylinder is then taken out and rubbed through a sifter. It is then either dried in the sun or baked into thin cakes on large flat iron plates. Cassava meal and cakes form an important item of the diet of the Indian tribes of tropical South America.

Sweet Potatoes.

Considerable attention has been given to the storage of sweet potatoes in the United States of America, and a technique of storage which has apparently given satisfactory results has been evolved there.(7) The essential points of the process are a preliminary curing process of ten days to two weeks duration at a temperature of 80° to 85°F., followed by storage in specially constructed stores at a temperature of 55°F. Such conditions are, however, unattainable under normal conditions in the tropics. Various methods have been attempted under tropical conditions and storage in pits or clamps has on the whole given the best results. In some recent trials in Barbados, the clamps were prepared by digging out the soil to make a shallow circular depression 3 to 4 inches deep and about 3 feet in diameter. The potatoes were stacked in this in a conical heap. The heap of potatoes was then covered with trash and a layer of soil placed over the trash. This method of storage was considered to be very successful, and to be quite practicable in areas where pests affecting sweet potato tubers are not prevalent.(8)

Results in Trinidad have also shown that under suitable conditions sweet potatoes can be stored in this way for about two months in fairly good condition with a loss in weight of about 15 per cent.

Some varieties keep very much better than others, and it is generally held that the red-skinned types are to be preferred for storage to the white or yellow-skinned types. The sweet potato, known in Trinidad as Black Rock, has a reputation for storage purposes.

In storing sweet potatoes care has to be taken to protect the skin from injury by bruising or cutting, as the skin is very delicate and if it sustains injury decay spreads rapidly.

Acknowledgments.

Acknowledgment of considerable assistance in the preparation of this memorandum is due to the Imperial Institute and to Sir Guy Marshall, C.M.G., D.SC., F.R.S., Director of the Imperial Institute of Entomology, and Professor J. W. Munro, Director of the Biological Field Station (Stored Products Research) Slough.

List of References.

1. First Report on Nutrition in the Colonial Empire, Part I, 1939.
2. Notes on the Storage of Foodstuffs compiled by the Imperial Institute. Volume 46, 1936, and *East African Agricultural Journal,* Volume II, No. 5, 1937.
3. Rice Storage Experiments by H. W. Jack and R. B. Jagoe, *Malayan Agricultural Journal,* Volume XVIII, p. 447, 1930.
4. The Municipal Granaries, Colombo, by B. Bunting. *Malayan Agricultural Journal,* Volume XVIII, p. 545, 1930.
5. The Storage of Padi in Kedah by W. N. Sands, *Malayan Agricultural Journal,* Volume XXI, p. 678, 1933.

6. Report on Insect Infestation of Cocoa Beans and Nuts. Manufacturing Confectioners Alliance, 1936.
7. Tropical Fruits and Vegetables. An Account of their Storage and Transport, by C. W. Wardlaw. Low Temperature Research Station, Imperial College of Tropical Agriculture, 1937.
8. Sweet Potato Storage Experiments by A. E. S. McIntosh. *Barbados Agricultural Journal,* Volume 7, No. 4, 1938.
9. Communal Grain Stores in Nysaland, by E. Lawrence. *East African Agricultural Journal,* Volume IV, p. 265, 1939.
10. Native Methods of Food Storage. *East African Agricultural Journal,* Volume V, p. 99, 1939.
11. Common Pests of Grain and Other Stored Products. Department of Scientific and Industrial Research, 1939.

Notes and Comments.

THE CONTROL AND DISTRIBUTION OF COAGULANTS IN MALAYA.

There have been several references recently in this Journal to the shortage, at the close of last year, of supplies of acids used for coagulating purposes in the rubber industry. This shortage was a direct consequence of the war, as Germany previously supplied a considerable proportion of Malaya's imports of formic acid, the acid principally used as a coagulant in recent years.

While estates had stocks of acid available, if limited ones in some cases, small-holders had no such reserves and prompt action was necessary to ensure that all small-holders received a fair share of available supplies at normal prices. Price control and limitation of stocks were effected under Defence and Emergency Regulations, and distribution to small-holders was undertaken by the Department of Agriculture.

Legislation was first introduced to control prices of formic acid and acetic acid, and on the 19th September, 1939, the price of formic acid was fixed at $13 per jar of 44 lbs. in the States of Perak, Selangor and Negri Sembilan, and at $13.50 in the State of Pahang. Later the price in Perak was raised to $13.50. Prices were again amended in 1940 and made applicable to the whole of the Federated Malay States. Retail prices (per beer or whisky bottle) were similarly controlled in October. Price control was instituted in the Straits Settlements in October.

In September, 1939, legislation was introduced in the Federated Malay States to control purchases of acid and to prevent hoarding. Under the Gazette Notification estates were required to obtain a permit from the State Agricultural Officer to hold stocks of coagulant in excess of 30 demijohns, and were not permitted to make fresh purchases of acid until their stocks were less than 30 days' supply; all new purchases were restricted to the quantity required in excess of their stocks to cover the ensuing 30 days' requirements. Dealers also came within the scope of the legislation, and all stocks in excess of 30 demijohns had similarly to be covered by a permit from the State Agricultural Officer.

Commencing at the end of November the supply of acid to small-holders was placed under the control of the Department of Agriculture. The Adviser on Agriculture was appointed an Authority under the Emergency Regulations with power to requisition stocks of formic acid. Acid was rationed in proportion to the area of rubber owned, and distribution was effected by the Field Branch in co-operation with the Land Offices. In the State of Selangor, for example, the small-holder first produced his Certificate of Registration of Rubber Cultivation to his respective Land Office and there had it endorsed with the quantity of acid to which he was entitled for a period of a fortnight. He then took the Certificate to the Malay Agricultural Assistant of his district from whom he purchased his ration of acid.

In December, 1939, the Controller of Rubber was appointed the Competent

Authority for the Federated Malay States and the Straits Settlements in respect of all coagulants, and under the Control of Coagulants Order 1939 all dealers and estates were required to forward particulars of stocks of coagulants held by them, and no coagulant could be sold or disposed of except by permission of the Controller of Rubber as Competent Authority. Estates were permitted to purchase a fortnight's supply from the larger dealers who had stocks of formic or acetic acid at the date of the Order, but small dealers were not allowed to carry on a retail trade since all sales to small-holders were restricted to the Field Branch of the Department of Agriculture. From the 1st January, 1940, new legislation was introduced under the Control of Coagulants Order 1940 providing, *inter alia*, for the issue of licences to importers, sellers and dealers.

Simplification of the scheme of rationing supplies to small-holders was introduced at the beginning of this year by the issue of coagulant coupons by District Officers when issuing the quarter's rubber export coupons. The coupons are for 1, 2 or 5 units of acid and are issued on a proportionate basis to the quantity of rubber covered by the rubber export coupons. The value, *i.e.*, quantity, of 1 unit of acid can be increased or decreased if necessary, depending upon the availability of supplies. Difficulty is still being experienced in obtaining stocks of formic acid, but satisfactory shipments of acetic acid are being received from Empire and other sources, and this acid is at present replacing formic acid as a coagulant.

The volume of work involved in this distribution of acid can be gauged from the fact that, in the State of Selangor, sales of acid to small-holders in December were 75,000 fluid ozs., 150,000 in January, and 250,000 in February. It must be remembered, also, that these sales are in small quantities of possibly 20 to 30 fluid ozs., and in December were as small as 1 to 5 fluid ozs.

This work has been carried out by the Field Branch without any increase in staff, but, commencing in March, distribution of acid has been placed in the hands of a limited number of licensed retail dealers under the supervision of the Controller of Rubber.

These retail dealers obtain their supplies from the importers under permit from the Controller of Rubber. These supplies are in sealed beer bottles in order to prevent adulteration by the retailer. The retailer is permitted to sell only against delivery of the relative number of coagulant coupons, which he then has to forward to the Controller of Rubber. The retailer thus has to produce coupons to cover all coagulant sold by him.

The shortage of acid has drawn attention to the possibility of using serum and fermented coconut milk as coagulants. The use of serum has been practised principally on estates and the larger small holdings. The Rubber Research Institute of Malaya published a leaflet in English on the use of serum and a separate leaflet in Malay, Chinese and Tamil, on the use of coconut milk. Asiatic Rubber Instructors have given frequent demonstrations of the method advocated for the use of coconut milk as coagulant. In coconut-growing areas the milk has been collected at copra kilns where large number of nuts are split, fermented for 4 or 5 days in

large earthenware jars, and then retailed at 20 cents per demijohn. Small-holders have used this home-made coagulant to eke out their ration of acetic acid. The continued use of coconut milk is not recommended, however, if adequate supplies of acid are available.

The shortage of acid has had the effect of bringing the Field Branch of the Department of Agriculture into even closer touch with the small-holder, though it cannot be claimed that in the majority of cases this has gone beyond the actual sale of acid. In the more outlying districts, however, small-holders have been more inclined to seek advice and help in their emergency.

The shortage has also drawn attention to the wasteful methods of the Malay small-holder in his use of acid. Whereas estates coagulate their latex on one day and machine it the next day, small-holders have been in the habit of coagulating and machining in one day. Undoubtedly a contributing factor to the adoption of this practice has been the danger of theft if latex is left unguarded in a small open coagulating shed overnight. In his desire to collect the latex and machine his rubber on the same day the small-holder uses from three to four times the normal quantity of acid in order to ensure rapid coagulation. While the lack of acid forced the abandonment of such generous use, and the present ration is based only on normal coagulation, reports indicate that it is extremely doubtful if any permanent change for the better has been effected. Many small-holders are using up their ration in the old wasteful manner and resting their trees for the remainder of the quarter, or else they are eking out their ration with the addition of coconut milk, sulphuric acid, or some of the proprietary coagulants which have appeared on the market as a result of the shortage.

PALM OIL AND PALM KERNEL OIL AS SOAP-MAKING MATERIALS.

There has been a considerable increase during recent years in the proportion of vegetable oils and fats used in soap-making, and in England the rise has been specially marked in the case of palm oil, though, rather strangely, in the United States the quantity of palm oil used in soap has correspondingly declined. Palm oil is such an excellent substitute for tallow and its price during recent years has been so low that its popularity as soap stock is not surprising. During 1939 the United Kingdom imported 131,441 tons of palm oil as compared with only 81,000 tons of palm oil and palm kernel oil together in 1913. Whereas formerly practically all palm oil came from West Africa, considerable quantities are now imported from the Dutch East Indies (Sumatra) and British Malaya.

Most of the palm oil used in soap-making is bleached before use to remove the reddish-yellow colouring matter, carotin, and various alternative methods of bleaching are available. Formerly, treatment with potassium dichromate and sulphuric acid, the so-called Watts' process, was commonly employed, but nowadays oxidation by air, with or without a catalyst, at various temperatures, or treatment with activated bleaching earth are more usually adopted. The activated earth is produced

by treating a natural fullers earth with sulphuric acid, and removing most of the acid by subsequent washing. In the treatment with activated earth the colouring matter of the oil is absorbed and thus removed from the bleached oil, so that on saponification a practically white soap is obtained, whereas by the oxidation methods, the colouring matter of the oil is oxidized but not removed, and the colour of the resulting soap is slightly creamish. On the other hand, the oxidation of the colouring matter produces irone, which has a violet odour, and the odour value of an air-bleached palm oil is therefore for some purposes superior to that of an earth-bleached oil. The question of the equal suitability of oils treated by the two different methods for toilet soap-making was raised in a recent legal action, when it was established that both types of oil are largely used in toilet soap-making, and so far as quality is concerned, and apart from colour, there is nothing to choose between them for soap-making. Of course, for edible purposes, where an odourless and tasteless oil is required, earth-bleaching is obviously to be preferred, as the colouring matter is removed and no odorous oxidation product is left in the oil.

Palm kernel oil, also obtained from the palm fruit (but from the inner kernel as distinct from the fleshy pericarp which yields the palm oil) is not used in soap-making in southern England so much as in the north, and it has always been much more popular in Germany than in England, whilst its use in the United States soap industry is almost negligible. It is very similar in properties to coconut oil, but is not commonly used for toilet soaps, and although it has been recommended particularly for the preparation of mottled soaps of low fatty acid content, it appears to have little if any advantage over coconut oil for this purpose.—*The Perfumery and Essential Oil Record,* Vol. 31, No. 1, 23rd January, 1940.

WHALE OIL.

According to information received from Oslo, the number of whales caught during the 1938-39 season in the Antarctic fell to 38,356, compared with 46,039 in the preceding season, and the production of whale oil to 2,870,771 barrels, as against 3,340,333 barrels. It is stated that there are now ten British-owned factory ships on the Antarctic whaling grounds, in addition to one land station in South Georgia, as against nine British expeditions previously. Additional to the British there are ten Norwegian factory ships, one United States and six Japanese now operating.—*Oil and Colour Trades Journal,* Vol. 97, No. 2154.

FIELD TRIALS:
Their Lay-out and Statistical Analysis*

Every agricultural experimenter, not least the plant breeder, is called upon sooner or later to carry out field trials, whether it be to determine the effect of different treatments upon one and the same variety, or to determine the relative value of a number of varieties grown under identical conditions; or it may be even

* By John Wishart, M.A., D.SC. Published by the Imperial Bureau of Plant Breeding and Genetics, Cambridge, Price 2 shillings and 6 pence.

the two together, to determine the reaction of a number of different varieties to different sets of cultural conditions. The concern of the investigator at the present day is to find the most efficient way of arranging such trials and the correct way of working out and interpreting the resulting data, and there is a great need still for some straightforward but authoritative exposition of these methods. The present bulletin fulfils just such a need. Written by the Reader in Statistics in the University of Cambridge, it is based on long experience of the difficulties of the layman in grasping the principles of applied statistics, experience acquired both in teaching students and interpretation of experiments. The bulletin, though designed primarily for the use of plant breeders, will be equally invaluable to experimenters in all branches of agricultural science. It is throughout couched in as nearly as possible non-technical language and all technical terms used are defined. It begins with a clear exposition of the nature of the problems confronting the field experimenter; there follow sections devoted to the methods of randomized blocks and the Latin Square, multiple factor experiments, confounding, and experiments with large numbers of varieties. All the methods are illustrated by examples.

The bulletin can be regarded as taking the place of the well-known Bulletin No. 10, "The Arrangement of Field Experiments and the Statistical Reduction of the Results," and serves as an introduction to the more complex problems dealt with in Bulletin No. 35, "The Design and Analysis of Factorial Experiments," both published by the Imperial Bureau of Soil Science.

Departmental.

FROM THE DISTRICTS.

Compiled in the Office of the Chief Field Officer from the Monthly Reports of Agricultural Officers.

March, 1940.

The Weather.

Throughout the country March has been notably dry. In Kedah conditions of extreme drought have been experienced, resulting in the failure of some village water supplies, the death of a certain number of cattle, and the withering of palms and fruit trees. In other parts the drought has not been so intense but in many rural localities difficulty has been experienced in obtaining water for domestic purposes.

In Kelantan the drought has also been particularly severe. At four out of the seven recording stations no rain fell at all; half an inch was recorded at one station and less at the remaining two.

Crop Reports.

Rubber.—The dry weather has caused a reduction in yield of rubber trees; many small-holders have temporarily curtailed tapping. The dry weather has resulted in the leaf disease *Oidium heveae* being much less prevalent than is usual at this time of the year.

There has been little alteration in the price of rubber. In Johore dealing in fresh latex has further increased; small-holders receive 10 to 13 cents per kati, the price paid being calculated in each case on the dry rubber content of the latex.

The sale of approved coagulants by dealers is in most cases proceeding smoothly. Acetic acid is now sold in sealed bottles at fixed prices. This makes it impossible for unscrupulous dealers to cheat by adulterating the acid. Sulphuric acid mixtures generally appear to be becoming more common. The danger of this acid as a coagulant is that an excess of it may affect the quality of the product. It is therefore specially unsuitable for use by small-holders who almost invariably use a larger quantity than is desirable in order to obtain rapid coagulation. An excess of formic or acetic acid is not so objectionable.

Some Chinese tappers on small-holding areas in Ulu Langat, Selangor, stopped work during the month. These tappers do not normally receive wages but work on the basis of sharing the produce with the owners of the holdings. They demanded not only a larger share than usual of the rubber produced but in addition a share in the export rights. Many small-holders with their families have resorted to tapping their own rubber rather than give in to the demands of the Chinese tappers. It remains to be seen how long this will continue. The work is not arduous and, in most instances, is well within the capabilities of a family on a small holding. Judged

from usual agricultural standards, therefore, it would be normal procedure for the family to do its own work.

Padi.—The harvest is now over in all localities. At Sungei Manik difficulty was experienced in obtaining help for the harvesting as most of the labour was engaged in felling jungle in Stage IV. A certain number of people came from the Bagan Datoh area, mostly women, but the price paid for harvesting amounted, where the padi was lodged, to as much as 50 per cent. of the crop, the normal rate in Krian being 20 per cent.

The intense dry weather has so far prevented the planting of nurseries in those parts of the country where an early season is customary, such as some of the riverine areas in Pahang.

The continued drought is causing some uneasiness among cultivators in Pahang. Many of them are storing their surplus padi rather than disposing of it to the Government Rice Mill or to dealers as they fear that it may not be possible to obtain a satisfactory crop in the coming season.

Early in March the price paid by dealers for padi in the Sungei Manik area fell to $2.50 per picul and padi began to come to the Government Rice Mill at Telok Anson. A temporary godown with a capacity of 10,000 piculs was erected at the mill to accommodate this padi as the other godowns were filled with padi purchased outside the area. By the end of the month some 4,000 piculs had been purchased, of which about 15 per cent. was sealed S.K. 48 and received the usual premium of 10 cents a picul. A certain amount of this strain was sold unsealed by growers who did not know that a premium was offered. Further action has been taken to induce padi planters to sell their padi to the mill and also to advertise that a premium is paid for Seraup 48.

Early in the month most of the padi sold to the mill was brought in by the Chinese middlemen. Later when the growers had finished harvesting they brought the padi to the mill themselves and less was sold to the dealers.

In Malacca a new padi area of 250 acres is being opened up at Duyong. It is hoped to get 170 acres planted this season. Government has granted a sum to assist settlers in clearing the land. Sawah areas are at present covered with a heavy growth of sikudana grass, the roots of which are tenacious and difficult to plough up with buffaloes. An attempt is being made to give the area an initial plough over with a tractor and disc plough. Excellent work has so far been done with this outfit, though the work is reported to be a little slow in the damper areas.

At Pahang Tua Padi Test Station, Pahang, yields have been high this year. MK.K. 3 in one block yielded at the rate of 900 gantangs per acre and Sm. 29 in another block 945 gantangs per acre. No block on the Station yielded less than 500 gantangs per acre.

Poultry.—Epidemics have been reported from various parts of the country. In central Johore a very severe epidemic has just occurred and many hundreds of birds have died. The Veterinary Officer and the Department of Agriculture cooperated to investigate the disease in that locality and it has definitely been diagnosed

by microscopical examination as fowl cholera, the causative organism of which is *Pasteurella avicida.*

In two isolated villages in Perak, R.I.R. cockerels have been distributed to small-holder poultry keepers and all the cockerels of the local breed have been destroyed.

Tobacco.—A cigarette factory is now in operation in Malacca. The factory has a capacity of 600,000 cigarettes a day, which are sold in Singapore, Malacca and Penang at 4 or 5 cts. per packet of twenty. These cigarettes find a ready sale locally among the working classes, who probably prefer a strong cigarette of this type with dark tobacco. Owing to the increased demand for dried leaf created by this factory prices in Malacca have recently risen considerably and now stand at $45 to $50 per picul.

Vegetables at Cameron Highlands.—A range of experiments on the manuring, cultivation, and pest control of vegetables has been under way for some months at the Tanah Rata Agricultural Station. Several methods have been tried to control the Plutella caterpillar on cabbages. Derris sprays were tried with little or no success; it appears that the spray will not adhere to cabbage leaves. Recently a 0.1 per cent. solution of a proprietary nicotine extract has been tried and found to give full control of the pest when sprayed every 4 days. The Agricultural Officer is now trying a home-made extract from local tobacco waste which would be much cheaper than the commercial product.

Mangoes at Briah Padi Test Station.—The Agricultural Officer, Krian, reports: "In spite of the weather, the budding of mangoes has been more successful of late; the technique now employed is patch budding with sprouted buds and not opening the tape for at least a month. Some seedlings have also been satisfactorily inarched."

DEPARTMENTAL.

Mr. W. J. B. Johnson, Canning Officer, returned from leave on 15th March, 1940.

Mr. J. A. Baker, Agricultural Officer, has been granted 157 days leave from 15th March to August, 1940, inclusive.

FERTILIZER PRICES, APRIL, 1940.

The following are the prices current for the month of April, 1940, of some of the more important fertilizers.

Product.	Analysis				Price per ton $
	Nitrogen (N)	Phosphoric Acid (P_2O_5)		Potash (K_2O)	
		Soluble	Insoluble		
Sulphate of Ammonia ...	20.6	—	—	—	114.00
Calcium Cyanamide ...	20.6	—	—	—	120.00
Muriate of Potash ...	—	—	—	60	150.00
Sulphate of Potash ...	—	—	—	48	not available
Superphosphate (concentrated) ...	—	39	—	—	140.00
Superphosphate ...	—	16-18	—	—	65.00
Basic Slag ...	—	16*	—	—	66.00
Rock Phosphate (Christmas Island) ...	—	11*	38‡	—	37 ¶
Rock Phosphate (very finely ground Gafsa) ...	—	11*	26 - 28‡	—	40.00
Lime ...	—	—	—	—	20.00

* Citric soluble. ‡ Total ¶ $35.00 per ton *ex* warehouse, Singapore.

Quotations are *ex* warehouse, Port Swettenham, Klang, Singapore and Penang, with the exception of muriate of potash which is *ex* warehouse, Port Swettenham, Klang and Singapore.

Statistical.

MARKET PRICES.

March, 1940.

Major Crops.

Rubber.—There was a considerable fall in values during the month. No 1. X. Ribbed Smoked Sheet opened at 38¼ cents per lb., and after rising to 39 cents on the 7th, fell steadily to close at 35¾ cents.

The average of daily quotations for the month was 37.65 cents per lb., as compared with 38.04 cents in February. The London average price was 11.70 pence per lb., and New York 18.39 cents gold, as compared with 12.60 pence and 18.67 cents gold respectively in February.

Prices paid for small-holders' rubber at three centres during the month are given in Table 1.

Table I.

Weekly Prices Paid by Local Dealers for Small-Holders' Rubber, March, 1940.

(Dollars per picul of 133 1/3 lbs.)

Grades	Kuala Kangsar, Perak	Kuala Pilah, Negri Sembilan			Batu Pahat, Johore.			
	27	7	14	21	6	13	20	27
Smoked sheet ...	46.00	46.00	45.20	44.50	42.90	44.60	—	—
Unsmoked sheet ...	—	44.00	44.00	—	—	42.50	41.40	41.16
Scrap ...	—	—	—	—	—	—	—	—

Transport by F.M.S.R. lorry service Kuala Pilah to Seremban 12 cents per picul, to Malacca excluding duty, 25 cents per picul, by rail Seremban to Penang $1.24 per picul, Seremban to Singapore $8 per ton.

Transport from Batu Pahat to Singapore by lorry, excluding duty, 90 cents per picul.

Transport from Kuala Kangsar to Prai by railway $6.20 per ton.

Transport from Kuala Kangsar to Singapore by railway $10 per ton (minimum consignment 5 tons).

At Kuala Pilah the standard deduction for moisture in unsmoked sheet is 5 per cent.

No purchases of rubber at Kuala Kangsar on the 6th, 13th, and 20th March, and at Kuala Pilah on the 28th March.

Palm Oil.—The following information is taken from *The Oil and Colour Trades Journal,* 1st March, 1940. Controlled maximum prices to large trade consumers and primary wholesalers to operate to 2nd March, naked *ex* mill or refinery, for quantities of 2 tons and upwards: palm oil, refined, deodorized £33 per ton, refined (hardened) deodorized £37. Under Acid Oils palm oil is quoted at £15 per ton and £20 (hardened).

Local sales of palm oil, 5 per cent. f.f.a. in sellers' drums, were made during March at the following prices: unbleached oil $190 per ton f.o.b. Port Swettenham.

Copra.—Sun-dried copra remained unchanged at $3.80 per picul. The mixed grade fell 5 cents to $3.40 per picul.

It is understood that a controlled price of £12 per ton for f.m.s. Straits copra is in force in the United Kingdom.

Coconut oil was sold in Singapore during March at an average price of $9.50 per picul f.o.b.

Copra cake fell to $1.50 per picul, averaging $1.80 as compared with $2 in February.

Rice.—The Singapore average wholesale prices of rice per picul in January, February and March of this year are as follows:—

	January	February	March
	$	$	$
Thailand No. 2 Ordinary ...	4.99	4.84	4.50
,, No. 1. Broken (White)	4.10	4.06	3.67
,, No. 2. Broken (White) ...	4.30	3.85	3.62
Rangoon No. 1 ...	No dealings	No dealings	No dealings
Rangoon Parboiled No. 2. ...	—	—	No dealings
Saigon No. 1 (Long Grain) ...	5.00	4.80	No dealings

The January average retail prices per gantang (gallon) of No. 2 Thailand rice were:—Singapore 30, Penang 32, Malacca 30, as compared with 28, 29 and 30 respectively in December 1939.

The average declared trade value of imports during January was $4.23 per picul, as compared with $3.99 in December and $3.79 in November 1939.

Padi.—The Government Rice Mills, Perak, are paying a guaranteed price of $2.50 per picul for padi, plus a bonus of 10 cents per picul for pure strain S.K. 48 padi. The Government Rice Mill, Temerloh, Pahang, was paying $2.25 per picul during March.

Retail prices of padi per 100 gantangs (gallons) were as follows:—Kedah $9 to $10, Province Wellesley and Penang $8.30, Krian, Perak, $8.40 to $9.60, Perak Central $9.37, Perak South $9 (Sungei Manik), $9.50 to $10 (Teluk Anson), Selangor $10.50 to $11.50 (Ulu Selangor and Kuala Lumpur), $10 to $15 (Ulu Langat), Negri Sembilan $8 to $12, ($14 to $16.50 Seremban, coast and Jelebu), Pahang East

$10 to $14,Pahang South $9.50 to $13, Malacca $12 to $14, Johore $14 to $18, Kelantan $10.80, Labuan $8, Brunei $12 to $15 ($14 to $17 Kuala Belait).

Pineapples.—There has been no change in the prices either for the canned product or for fresh fruit but trading is more or less at a standstill pending the outcome of negotiations regarding licences for import into the United Kingdom.

Beverages.

Tea.—No London prices are available.

The latest Colombo prices available, quoted from *The Ceylon Tea Market Report* of 12th March, 1940, of the Colombo Brokers' Association, are as follows, in rupee cents per lb.:—High Grown 97, Medium Grown 83, Low Grown 80.

Coffee.—Liberian and Robusta coffee were quoted throughout the month in Singapore at $17 and $9.50 per picul respectively. Excelsa rose from $14 to $15, averaging $14.75 per picul.

The average of highest and lowest quotations in Singapore for Palembang coffee was $10.12 to $12 per picul, and for Sourabaya $13.12 to $14.12. The February average prices were $8.80 to $11.55 and $14.30 to $15.25 respectively.

Spices.

Arecanuts.—The averages of the Singapore Chamber of Commerce quotations per picul, which were stated to be approximate, were:—Best $5.55, Medium $5.10, Mixed $4.85.

The averages of the highest and lowest quotations per picul in Singapore were as follows:—Splits $3.56 to $4.62, Red Whole $4.62 to $5.62, Sliced $5.81 to $7.56, as compared with $4 to $5.33, $5.05 to $6.20, and $7 to $9.80 in February.

Pepper.—Singapore Black fell to $8, averaging $8.15 per picul, Muntok White fell to $14, averaging $14.05. The February averages were $8.50 and $14.50 respectively. The market for Singapore White continued nominal with no quotations.

Nutmegs.—110's fell from $34 to $27 per picul, averaging $31.80, and 80's fell from $41 to $37, averaging $40.20. February average prices were $34 and $41 respectively.

Penang dried nutmegs were sold at $25 per picul.

Mace.—A nominal market with no quotations. Locally produced mace, dry, was sold in Penang at $75 per picul.

Cloves.—A nominal market with no quotations. Penang cloves, dried, sold in Penang at $82 per picul 1st quality.

Cardamoms.—Green cardamoms were quoted in *The Ceylon Chamber of Commerce Weekly Report* of 11th March, 1940, from Rs. 1.45 to Rs. 1.59 per lb.

Miscellaneous.

Derris.—Demand was negligible during March but prices remained unchanged compared with February. Average prices per picul were as follows:—$11 to $12 for roots sold on a basis of ether extract, $22 to $24 for roots sold on rotenone content.

Gambier.—Cube No. 1 fell to $14, averaging $14.60 per picul as compared with $15 in February. The market for Block continued nominal with no quotations.

Sago.—Pearl fell to $9, averaging $9.19 per picul, and Flour, Sarawak Fair, fell to $5.75, averaging $6.27. The February averages were $9.25 and $6.25 respectively.

Tapioca.—Flake Fair fell to $9.50, averaging $9.90 per picul; Seed Pearl fell to $10.50, averaging $10.90; and Medium Pearl was unchanged at $11. Average prices in February were $10, $11 and $11 respectively.

Tobacco.—Prices of prepared tobacco per picul in Kelantan during March were: 1st quality $100 to $160, 2nd quality $65 to $128, 3rd quality $45 to $112. In Perak Central the corresponding prices for cut tobacco were $62, $55 and $30, and for dried leaf $40, $29.50 and $16.50. In Perak South locally prepared tobacco was sold at 60 to 95 cents per kati, and dried leaf at $40, $35 and $30 per picul for the three grades. In Selangor prepared tobacco was sold at 80 cents to $1.35 per kati. In Negri Sembilan the range for dried leaf was $26 to $28, $16 to $25, and $8 to $10 ($16 to $20 in Tampin, Rembau and Jelebu). In Pahang South dried leaf was $22 to $36 per picul, and cut tobacco 44 to 96 cents per kati. In Penang and Province Wellesley dried leaf was $36 1st quality and $33 2nd quality. In Kedah 1st quality was $60 per picul. In Johore dried leaf ranged from $13.50 to $45 and prepared tobacco from $30 to $152.

The above prices are based on London and Singapore daily quotations for rubber, on the Singapore daily prices for copra, on the Singapore Chamber of Commerce Weekly Reports for the month and on other local sources of information. Palm oil reports and certain coffee prices are kindly supplied by Guthrie & Co. Ltd., Kuala Lumpur, local palm oil prices by Whittall & Co., Kuala Lumpur, the Singapore prices of imported coffee and arecanuts by Lianqui Trading Company of Singapore, and Singapore derris prices by Hooglandt & Co., Singapore.

1 picul = 133 1/3 lbs. The dollar is fixed at two shillings and four pence.

Note.—The Department of Agriculture will be pleased to assist planters in finding a market for agricultural produce. Similar assistance is also offered by the Malayan Information Agency, 57, Trafalgar Square, London, W.C.2.

MALAYAN AGRICULTURAL EXPORTS, JANUARY, 1940.

PRODUCT	Net Exports in Tons		
	Year 1939	January 1939	January 1940
Arecanuts ...	38,489	3,710	4,720
Coconuts fresh†‡ ...	97,275†	7,445†	7,107†
Coconut oil‡ ...	61,360	4,848	5,644
Copra‡ ...	34,420	640*	1,706*
Copra cake ...	10,707	855	503
Gambier, all kinds ...	1,572	67	45
Palm kernels ...	10,774	998	746
Palm oil ...	59,712	3,326	2,946
Pineapples, canned ...	65,802	4,487	5,583
Rubber¶ ...	361,484¶	32,574¶	57,680¶
Sago,—flour ...	9,583	1,082	1,352*
,, —pearl ...	3,883	206*	374
,, —raw ...	4,435*	187	337*
Tapioca,—flake ...	1,068	33	136
,, —flour ...	2,706*	144*	158
,, —pearl ...	18,277	1,092	227
Derris ...	1,356	24	143
‡Copra equivalent ...	136,075	7,387	7,608

† hundreds in number. * net imports. ¶ production.

MALAYAN PRODUCTION OF PALM OIL AND KERNELS

(In long tons, as declared by Estates).

Month 1940	Palm Oil			Palm Kernels		
	F.M.S.	U.M.S.	Malaya	F.M.S.	U.M.S.	Malaya
January ...	2,007.6	2,474.0	4,481.6	434.3	497.0	931.3
February ...	1,937.9	1,914.7	3,852.6	411.1	454.0	865.1
Total ...	3,945.5	4,388.7	8,334.2	845.4	951.0	1,796.4
Total January & February, 1939	4,595.9	4,419.6	9,015.5	802.6	784.0	1,586.6
Total for the year 1939 ...	30,157.7	27,215.0	57,372.7	5,639.3	4,533.1	10,172.4

Stocks on estates as at 29th February, 1940, were: palm oil 2,655, tons, palm kernels 1,162 tons.

ACREAGES OF TAPPABLE RUBBER ACTUALLY TAPPED AND NOT TAPPED ON ESTATES OF 100 ACRES AND OVER, FOR THE MONTH ENDING 29TH FEBRUARY, 1940.

STATE OR TERRITORY	Estimated Acreages of Tappable Rubber (9)+(11)	ACREAGES OF TAPPABLE RUBBER NOT TAPPED				Area of tappable rubber never been tapped (b)		Total area not tapped (3)+(5) (c)		TOTAL AREA TAPPED DURING THE MONTH		Area of tappable rubber rested under rotational systems (c)	
		On estates which have entirely ceased tapping		On estates which have partly ceased tapping (a)									
		Acreage	Percentage of (3) to (2)	Acreage	Percentage of (5) to (2)	Acreage	Percentage of (7) to (2)	Acreage	Percentage of (9) to (2)	Average	Percentage of (11) to (2)	Acreage	Percentage of (13) to (2)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
S.S.—													
Province Wellesley ...	42,879	114	0.3	11,975	27.9	505	1.2	12,089	28.2	30,790	71.8	8,481	19.8
Malacca ...	116,501	1,979	1.7	19,748	16.9	1,598	1.4	21,727	18.6	94,774	81.4	25,247	21.7
Penang ...	2,549	63	2.5	705	27.6	35	1.4	768	30.1	1,781	69.9	60	2.4
Singapore ...	31,892	4,939	15.5	6,200	19.4	241	0.8	11,139	34.9	20,753	65.1	3,493	11.0
Total S.S. ...	193,821	7,095	3.7	38,628	19.9	2,379	1.2	45,723	23.6	148,098	76.4	37,281	19.2
F.M.S.—													
Perak ...	282,938	6,451	2.3	38,226	13.5	6,480	2.3	44,677	15.8	238,261	84.2	42,300	15.0
Selangor ...	314,186	3,758	1.2	33,986	10.8	5,292	1.7	37,744	12.0	276,442	88.0	47,871	15.2
Negri Sembilan ...	259,395	6,189	2.4	43,656	16.8	9,206	3.5	49,845	19.2	209,550	80.8	36,879	14.2
Pahang ...	86,013	1,838	2.1	15,449	18.0	3,942	4.6	17,287	20.1	68,726	79.9	7,339	8.5
Total F.M.S. ...	942,532	18,236	2.0	131,317	13.9	24,920	2.6	149,553	15.9	792,979	84.1	134,389	14.3
U.M.S.—													
Johore ...	477,014	9,957	2.1	88,518	18.5	31,625	6.6	98,475	20.6	378,539	79.4	56,521	11.8
Kedah ...	188,777	6,307	3.3	18,830	10.0	6,053	3.2	25,137	13.3	163,640	86.7	37,353	19.8
Kelantan ...	31,240	403	1.3	4,717	15.1	1,592	5.1	5,120	16.4	26,120	83.6	5,544	17.7
Trengganu (d) ...	4,817	nil	nil	40	0.8	nil	nil	40	0.8	4,777	99.2	1,500	31.1
Perlis (e) ...	1,459	243	16.7	253	17.3	144	9.9	496	34.0	963	66.0	154	10.6
Brunei ...	5,971	nil	nil	1,161	19.4	270	4.5	1,161	19.4	4,810	80.6	1,140	19.1
Total U.M.S. ...	709,278	16,910	2.4	113,519	16.0	39,684	5.6	130,429	18.4	578,849	81.6	102,212	14.4
Total MALAYA ...	1,845,631	42,241	2.3	283,464	15.3	66,983	3.6	325,705	17.6	1,519,926	82.4	273,882	14.8

Notes.—(*a*) Area out-of-tapping on estates which have partly ceased tapping refers to areas definitely being rested and excludes areas on any tapping round.

(*b*) The acreage shown in column (7) is included in columns (3) and (5).

(*c*) Areas of tappable rubber rested under rotational systems are not considered as out-of-tapping and therefore columns (11) and (12) include columns (13) and (14) respectively.

ACREAGE, STOCKS, PRODUCTION, IMPORTS AND EXPORTS OF RUBBER, INCLUDING LATEX, CONCENTRATED LATEX AND REVERTEX, FOR THE MONTH OF FEBRUARY, 1940, IN DRY TONS.

State or Territory	Stocks at beginning of month 1			Production by Estates of 100 acres and over		Production by Estates of less than 100 acres estimated 2		Imports				Exports including re-exports				Stocks at end of month			Consumption 3	
								during the month		January & Feb. 1940		during the month		January & Feb. 1940						
	Ports	Dealers	Estates of 100 acres and over	during the month	Jan. & Feb. 1940	during the month	Jan. & Feb 1940	Foreign	From Malay States & Labuan	Foreign	From Malay States & Labuan	Foreign	Local	Foreign	Local	Ports	Dealers	Estates of 100 acres and over	during the month	Jan. & Feb. 1940
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
MALAY STATES :—																				
Federated Malay States ...	...	7,519	25,588	13,058	28,498	4,922	18,699	Nil	Nil	Nil	Nil	15,038	7,357	29,494	19,161	...	5,526	23,146	20	44
Johore ...	...	3,049	9,276	5,932	12,932	3,157	12,200	Nil	83	Nil	180	3,466	7,490	7,252	18,509	...	1,970	8,571	...	...
Kedah ...	...	382	6,228	2,956	6,930	1,022	2,868	Nil	Nil	Nil	Nil	1,674	2,924	3,682	6,929	...	255	5,735	...	...
Perlis ...	...	25	40	16	37	26	72	Nil	Nil	Nil	Nil	Nil	43	Nil	109	...	16	48	...	...
Kelantan ...	...	372	683	412	858	981	2,302	Nil	Nil	Nil	Nil	86	1,218	148	2,871	...	444	700	...	...
Trengganu ...	...	91	269	164	375	329	777	Nil	Nil	Nil	Nil	Nil	569	Nil	1,186	...	39	245	...	...
Brunei ...	...	11	65	68	140	87	168	...	...	...	...	...	142	...	302	...	14	72	...	...
Total Malay States	...	11,449	42,149	22,606	49,770	1,524	37,086	Nil	83	Nil	180	20,264	19,746	40,576	49,067	...	8,264	38,517	20	44
S. SETTLEMENTS :—																				
Malacca ...	...	2,181	2,57	1,174	2,625	667	1,836	Nil	18,005	Nil	42,231	3,144	Nil	6,148	Nil	...	1,744	2,178	...	...
Province Wellesley	...	923	1,200	421	1,033	191	529	Nil		Nil		10,356		18,834		...	547	1,046	...	...
Penang ...	2,733	3,777	19	18	41	95	212	2,656		6,785						2,200	3,037	15	...	...
Singapore ...	10,088	19,376	288	153	347	101	137	13,896		39,842		28,341		52,761		11,877	16,494	291	10	33
Labuan ...	...	38	Nil	Nil	Nil	16	30	46		112		Nil		Nil		...	13	Nil	...	...
Total Straits Settlements ...	12,821	26,295	3,764	1,766	4,046	1,070	2,744	16,598	18,005	46,739	42,231	41,841	Nil	77,743	Nil	14,077	21,835	3,530	10	33
Total Malaya ...	12,821	37,744	45,913	24,372	53,816	11,594	39,830	16,598	18,088	46,739	42,411	62,105	19,746	118,319	49,067	14,077	30,099	42,047	30	77

TABLE II
DEALERS' STOCKS, IN DRY TONS 3

Class of Rubber	Federated Malay States	S'pore	Penang	Province We'sly D'dings M'cca.	Johore	Kedah
22	23	24	25	26	27	28
DRY RUBBER	4,551	15,361	2,883	1,983	1,658	155
WET RUBBER	975	1,133	154	335	312	100
TOTAL ...	5,526	16,494	3,037	2,318	1,970	255

TABLE III
FOREIGN EXPORTS

PORTS 29	For month 30	Jan. & Feb. 1940
Singapore ...	44,308	82,113
Penang ...	12,177	24,481
Port Swettenham.	5,399	11,181
Malacca ...	221	544
MALAYA ...	62,105	118,319

TABLE IV
DOMESTIC EXPORTS 4

AREA 32	For month 33	Jan. & Feb. 1940 34
Malay States ...	39,869	89,411
Straits Settlements	2,882	6,656
MALAYA ...	42,751	96,067

Notes:—

1. Stocks on estates of less than 100 acres and stocks in transit on rail, road or local steamer are not ascertained
2. The production of estates of less than 100 acres is estimated from the formula : Production + Imports + Stocks at beginning of month = Exports + Stocks at end of month, + Consumption, *i.e.*, Column [7] = Columns [13] + [14] + [17] + [18] + [19] + [20] − [2] − [3] − [4] − [5] − [9] − [10]. For the Straits Settlements the production of estates of less than 100 acres is represented by sales or exports as shown by cess paid.
3. Dealers' stocks in the Federated Malay States are reduced to dry weights by the following fixed ratios: unsmoked sheet, 15% wet sheet, 25% scrap, lump, etc., 40%; stocks elsewhere are in dry weights as reported by the dealers themselves.
4. Columns (33) and (34) represent exports of rubber subject to regulation which, for Singapore and Penang Islands are represented by sales or exports as shown by cess paid.
5. All statements are brought up to date monthly, and any inaccuracies that may be disclosed are corrected in the totals; the latest publication therefore, is always the most reliable.
6. The above, with certain omissions, is the Report published by the Registrar-General of Statistics, S.S and F.M.S., at Singapore on 28th March, 1940.

METEOROLOGICAL SUMMARY, MALAYA, FEBRUARY, 1940.

Locality.	Air Temperature in degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine.		
	Means of			Absolute Extremes						Total.		Most in a day.	Number of days.					Total.	Daily Mean.	Per cent.
	A. Max.	B. Min.	Mean of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot	At 4 feet			Amt.	Precipitation .01 in or more	Precipitation, .04 in or more	Thunder-storm	Fog morning obs.	Gale force 8 or more			
	°F	°F	°F	°F	°F	°F	°F	°F	°F	in.	mm.	in.						hrs.	hrs.	
Kuala Lumpur Aerodrome Selangor ...	91.5	71.5	81.5	95	69	89	74	84.6	85.6	5.98	151.9	1.94	15	12	5	3	—	221.10	7.62	63
Port Swettenham Aerodrome, Selangor ...	89.6	70.5	80.1	93	67	86	74	86.1	85.7	7.04	178.8	2.84	10	10	—	—	—	226.10	7.80	65
Sitiawan, Perak ...	89.5	72.4	80.9	92	70	83	75	83.6	84.5	5.64	143.3	1.35	12	12	2	—	—	238.95	8.24	69
Ipoh Aerodrome, Perak ...	91.5	71.9	81.7	94	69	84	75	83.7	84.4	6.14	156.0	3.05	11	9	3	—	—	231.10	7.97	67
Temerloh, Pahang ...	88.8	69.4	79.1	92	66	81	73	85.0	85.4	0.79	20.1	0.22	7	6	—	3	—	213.20	7.35	61
Kuala Lipis, Pahang ...	87.9	70.1	79.0	91	66	81	73	82.8	83.5	2.35	59.7	0.84	9	8	—	13	—	201.90	6.96	58
Kuala Pahang, Pahang ...	83.1	74.5	78.8	85	70	81	77	83.7	85.0	3.23	82.0	0.80	9	8	—	—	—	223.85	7.72	64
Kallang Aerodrome, S'pore ...	87.5	73.3	80.4	90	70	82	75	81.3	82.4	4.20	106.7	1.43	6	6	3	—	—	221.55	7.64	63
Bayan Lepas Aerodrome Penang ...	89.7	72.7	81.2	93	69	86	76	84.2	84.5	0.95	24.1	0.63	4	3	—	—	—	267.05	9.21	77
Malacca Town, Malacca ...	89.0	73.1	81.1	92	71	85	75	84.9	85.3	1.43	36.3	0.62	7	4	—	—	2	235.35	8.11	67
Kluang, Johore ...	88.0	70.7	79.3	93	68	83	73	80.0	81.0	3.26	82.8	2.87	7	6	—	—	—	230.20	7.94	66
Mersing, Johore ...	82.8	74.0	78.4	85	67	79	77	80.1	80.4	1.80	45.7	0.71	8	5	—	—	—	236.70	8.16	67
Alor Star, Kedah ...	94.5	69.3	81.9	98	64	89	75	86.5	86.1	nil	—	—	—	—	—	1	—	278.50	9.60	81
Kota Bahru, Kelantan ...	85.1	69.3	77.2	88	65	81	75	80.3	82.1	2.10	53.3	0.62	7	5	—	1	—	253.95	8.76	74
Kuala Trengganu, Trengganu	†																			
Labuan ...	83.7	75.1	79.4	86	73	77	78	83.4	84.6	11.80	299.7	3.66	14	12	—	—	—	185.35	6.39	53
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft.	70.0	60.1	65.1	76	57	65	63	70.7	70.9	6.50	165.1	3.01	20	16	—	15	—	155.35	5.36	45
Cameron Highlands, Tanah Rata, Pahang 4750 ft. ...	71.1	53.2	62.2	74	47	68	62	68.6	68.9	2.84	72.1	0.85	14	9	—	3	—	159.85	5.51	46
Cameron Highlands, Rhododendron Hill, Pahang 5120 ft. ...	71.5	57.7	64.6	76	54	65	60	*	*	3.22	81.8	1.11	12	9	—	—	—	174.65	6.02	50

* Not recorded.